IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF WEST VIRGINIA
AT CHARLESTON

OHIO VALLEY ENVIRONMENTAL COALITION, INC., WEST VIRGINIA HIGHLANDS CONSERVANCY, INC., and SIERRA CLUB,

Plaintiffs,

v. CIVIL ACTION NO. 2:13-5006

FOLA COAL COMPANY, LLC,

Defendant.

Huntington, West Virginia
August 20, 2014

TRANSCRIPT OF BENCH TRIAL - DAY 2
BEFORE THE HONORABLE ROBERT C. CHAMBERS
UNITED STATES DISTRICT JUDGE

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Wednesday, August 20, 2014, at 9:06 a.m. in open court

THE COURT: All right. Ready to resume with the examination of Dr. King?

MR. LOVETT: A couple of quick housekeeping matters, if that's okay, Your Honor.

THE COURT: Okay. Use the microphone so we can hear you.

MR. LOVETT: Sorry.

THE COURT: Is that on?

MR. LOVETT: Yeah, it is. It's about the exhibits. We've agreed that in terms of joint exhibits to wait until the end of testimony. I think that we all agree that all the joint exhibits are admitted and admissible except for the ones that we do not use during the trial.

So in terms of --

THE COURT: Well, all right. I'll let him continue to refer to them. I understand you're going to move at the end of the trial to admit those that have been referred to.

MR. LOVETT: Thank you. And one other thing. Yesterday I failed and would like to now move the admission of Defendant's 8.

THE COURT: Defendant's 8?

MR. LOVETT: Yes, which is the total maximum daily loads for streams in the Gauley River --

THE COURT: All right. Any objection to that?

MR. HARVEY: No objection.

THE COURT: All right. It's admitted.

MR. LOVETT: Thank you.

THE COURT: All right. Are you ready to resume with Dr. King?

MR. BECHER: Yes, Your Honor.

THE COURT: Dr. King, if you'll take the stand again.

BY MR. BECHER:

Q. Good morning, Dr. King.

A. Good morning.

Q. I believe where we left off yesterday, we were talking about different taxa of macroinvertebrates, bugs, that were sensitive to conductivity. Is that your recollection?

A. Yes.

Q. Can you explain to me why viewing macroinvertebrates in this way or in the multi-metric index, like the WVSCI or GLIMPSS that has been referred to, is useful for ecologists?

A. Well, you know, looking at the individual taxa that --

THE COURT: Hold on just a minute. I'm sorry to interrupt you. I want to make sure your microphone -- it looks like it's on.

(The Court and Clerk conferred privately off the record.)

THE COURT: We're going to turn it off and turn it back on again. There we go. All right. Sorry for the

interruption.

THE WITNESS: No problem. So as I was saying, individual taxa have different sensitivities. So looking at the taxa that comprise the community at an individual site provides an additional level of information about specificity, you know, where you consistently see taxa that you know to be sensitive and they're there when conductivity is low versus taxa you know to be tolerant and those are the only ones you find when you see conductivity when it's high, for example.

BY MR. BECHER:

Q. Now, are these bugs that we see declining with conductivity, are they particularly sensitive or weak bugs overall?

A. It varies. Not necessarily. You know, there are certainly some that have much greater tolerance to degradation; for example, mayflies. If we were to just look at mayflies as a group and the number of mayflies you'd expect to find with increasing, say, habitat degradation, some of them don't change much at all, at least in the way we measure habitat in terms of, you know, quality in a stream.

So, no, it's not -- they're often very specific to particular stressors.

Q. And why are we looking at bugs at all rather than just looking at, say, the chemistry data from these sites or physical measurements?

A. Well, I mean that's a pretty deep question in many ways, but I mean in terms of, you know, legally, we're to protect the biological integrity based on the Clean Water Act. And so understanding how chemistry is affecting aquatic life in a stream is fundamental to, you know, maintaining clean water in this country. And these organisms are long-term integrators of the condition.

So as the conductivity goes up and down, we may go to a site and measure a value that isn't indicative of the long-term condition, whereas the organisms that are there will tell you a lot more about that, because it's more like a snapshot versus, like, a movie reel. A community of organisms in a stream has often been kind of a -- the analogy is that they are sort of like a long-term, you know, movie of what's happened.

Q. Thank you. I want to -- we started going through the literature yesterday. I want to continue a little bit.

If you would turn to Plaintiffs' Exhibit 2, it's your "How Many Mountains" paper that we talked about a little bit yesterday.

A. Okay.

Q. First, can you -- well, strike that. First, can you tell us generally what you're trying to do in this paper, what your main point of focus was?

A. Well, at the time when we started writing it, the

objectives were to formally link or address the area -- the spatial extent of mining in a catchment or a watershed and how that related to chemical changes in a stream. So, is there a relationship between how large a mine is relative to the total watershed?

At the time we were working on it, that was new. However, you know, there had been, for example, the Merriam paper looked at that a little bit and some others that came out before ours did and essentially found the same thing we did. That was one aspect of it.

And then another was to look more -- once we made that association, was to look at conductivity and then also sulfate, which was a very strong correlate or component of that ionic mixture, and how it corresponded to biological measures of stream integrity and including two that are used to assess impairment. Well, in West Virginia, technically only one, WVSCI, but GLIMPSS is also a genus-level index. And then finally to assess how individual taxa responses, using an entirely different method, that being the TITAN method, corresponded to results derived by the EPA benchmark using individual taxa or genera. So we had several objectives.

Q. And were you aware of the benchmark when you worked on this paper?

A. Sure. It was a draft document in 2010; and, you know, we were very aware of it. Again, the goal wasn't to necessarily

validate it. It was simply to look at this data in a different way. We screened the data in a very different way; and it was simply to see, well, how do our results compare.

Q. I want to turn to the same exhibit, page PE 23. There's a table 1 there.

A. Yes.

Q. And there's a response variable column. Can you tell me the response variables that you were looking at in these analyses?

A. Sure. In these three cases, we were looking at, first of all, the responses were the cumulative individual taxa responses which was analyzed with TITAN, and then we were looking at WVSCI, particularly where the WVSCI score reached its failing point, and the GLIMPSS score, where it reached its failing point.

Q. So you were using three different response variables here.

A. Correct.

Q. Okay. And how does that differ in the response variables that EPA looked at?

A. Well, I mean EPA did somewhat, you know, address the WVSCI. There is a figure where they estimate the percentage of sites that are predicted to be impaired with WVSCI; and at 300, it was 59 percent, I think.

And the main difference here was the cumulative

individual taxa responses was analyzed a very different way than the species sensitivity distribution approach that EPA used. In our case, we used the occurrence and the abundance of particular taxa. And the TITAN method tries -- attempts to identify the point where there is a sharp non-linear decline in the occurrence and/or abundance of a taxon. It's not attributed to a particular level of extirpation, for example.

So in EPA's case, they focused entirely on whether it occurred or not and then at what point was it basically going almost extinct. So ours was looking more at where individual taxa were really starting to be affected and is there a point where a lot of taxa simultaneously are affected. If there were, we would have this response that was really strong in a specific zone.

That's what TITAN does. It aggregates the responses of those taxa to identify a community-level threshold. So that's how it is very different from what EPA did.

Q. So you used analyses based on WVSCI, GLIMPSS, and TITAN.

A. Yes.

Q. And they used primarily WVSCI and species sensitivity distribution.

A. Yeah. And the benchmark really is entirely based on the species sensitivity, and then they had some additional analysis where they looked at WVSCI, but it was not a huge component of their work.

Q. Despite using these different types of evidence, were your results consistent with those of EPA?

A. They were remarkably consistent, yes. So, you know, in our case, we were looking at what level did WVSCI, with conductivity, for example, where did it hit the point where -- where did the model say that it, you know, on average, a site would be impaired. And we found that it would be at 308 microsiemens per centimeter. And our model actually accounted for habitat as well.

So getting rid of any potential confounding effect of habitat, in addition to all the other variables we screened, 308 was the number.

Q. And that's what you got, it looks like, for WVSCI and GLIMPSS as a threshold estimate.

A. Correct.

Q. What did you get for the TITAN analysis?

A. 283, with a confidence interval of 178 to 289. So, you know, basically just below 300.

Q. And remind us, what was the benchmark threshold?

A. 297.

Q. And so these are very consistent with that level.

A. Yes, and, you know, again, entirely different methods, completely -- I mean there would be a great potential for the results to be very different.

Q. I also want to talk a little bit about the datasets that

were used in "How Many Mountains." Can you tell us a little bit about -- you mentioned eliminating confounding factors -- how you arrived at the datasets for these analyses?

A. How we screened our data?

Q. Sure.

A. Yeah. Well, so in our case --

Q. Let me back up, actually. I hate to interrupt you. Which -- where was your data from?

A. Okay. Our data was a subset of data from the West Virginia DEP. And the reason why it was a subset and not the full dataset is we had a region of South West Virginia where we had mapped the aerial extent of mining, and hence that area is where we defined our study area.

So that eliminated a large part of the state, but -- and then from there, we obtained data mostly collected between 2000 -- well, up to 2007 is I think the dataset. And we screened those data for numerous potential confounding factors, such as the amount of urban development in the catchment, which has been shown in a variety of places, including one of the papers we talked about yesterday, as something that is certainly a confounding factor. It would very likely lead to degradation in the stream independent of mining.

So we got rid of sites that had more than 4.3 percent per recovered.

Q. So you used a small subset of the West Virginia database. What database did the EPA use in deriving their benchmark?
A. They used the West Virginia DEP database that was not for the entire state; most of the state. Ecoregions 69 and 70. And they also used a dataset from region -- EPA Region 3, which was a smaller dataset, but they went ahead and included that because it overlapped with that area.
Q. And so they had a larger dataset --
A. They had a much larger -- yeah, 2200 data points, compared to our dataset after it had been screened was 223 data points.
Q. Did they look at any data outside of West Virginia?
A. They did. After they had done all of their analyses, one of the steps that they did to validate what they had found was to look at -- essentially develop an entirely new species sensitivity distribution using data from the State of Kentucky. And I think that's something that is -- it's in an appendix. So a lot of times people aren't aware that they had actually done this. But they reproduced the entire thing for a dataset from a different state.
Q. Let's just very briefly point to that appendices, appendix G, which is the -- I apologize, Your Honor -- appendix G, which is the first exhibit in the joint exhibits notebook, 58, appendix --
THE REPORTER: I'm sorry. Say that again, slower.

MR. BECHER: This is part of Joint Exhibit 81 -- or, excuse me -- Joint Exhibit 58. Joint 58 is actually split in the middle because it's such a large document. And this part of that exhibit is the second joint exhibit notebook.

THE COURT: And it's appendix G?

MR. BECHER: G.

THE COURT: Do you know what page that starts on?

MR. BECHER: JE 589.

BY MR. BECHER:

Q. And can you just look at that briefly and tell me if this is the analysis that you're talking about --

A. Yeah, it is.

Q. So you've already said that the analyses you did using the highly screened portion of the West Virginia database consistent with the EPA's derivation in their main work was consistent with the dataset they found in Kentucky?

A. Yeah. Yes.

Q. Do you know of anybody else that did these kind of analyses with different datasets or different methods?

A. Well, we already discussed several different papers, you know, for example, the Pond work.

Q. So Pond used an even different dataset than was used in either your work or --

A. Yeah, it was entirely -- yeah. They generated their own dataset. And that was a focused study. Rather than using

Pond monitoring data, they went out and actually collected data more intensely. And that was the only reason why we saw -- they saw relationships in those data that were quite a bit stronger than what we see from the snapshot data from the biomonitoring approach.

Q. And all these datasets and all of these different methods, are they coming to similar conclusions?

A. Yeah. I mean, in fact it's remarkably similar. So it seems to be, regardless of where the sampling was done, how it was sampled, when it was sampled, and other sorts of variables included, the results are the same.

So I mean it's really getting to the point where we have a substantial literature that is arriving at this conclusion that conductivity associated with alkaline mine drainage is very strongly linked to biological degradation; and it seems to happen at levels around 300 is where it starts, and it continues to get worse as conductivity increases.

So there's this very clear dose response --

Q. I'll ask you some questions about that work in a moment. I want to have you read from some of the literature, and I want to start with the "How Many Mountains" paper.

If you could, turn to -- this is, again, Plaintiffs' Exhibit 2, page PE 25.

A. Okay.

Q. And you have a Stressor Gradient 2, Conductivity heading.

Can you read me the paragraph that falls immediately after that heading?

A. "As with the mining gradient, the diversity of intolerant macroinvertebrate taxa declined rapidly with increases in stream conductivity, with the conductivity model capturing more variation in the number of sensitive taxa" --

THE COURT: Slow down some.

THE WITNESS: I'm sorry. "With the conductivity model capturing more variation in the number of sensitive taxa than percent mining." And this was the GAM result, with an R-square of 0.45.

Mike, how far do you want me to read?

BY MR. BECHER:

Q. To the end of the paragraph.

A. Okay. "Based on the GAM models" -- GAM refers to generalized additive models -- "once stream conductivity increases above 121 or 308 microsiemens per centimeter, GLIMPSS and WVSCI scores will typically fall below their respective impairment thresholds. TITAN revealed significant declines in abundance for 50 of the 157-recorded taxa in response to rising conductivity, with the greatest cumulative community diversity loss observed at 283 microsiemens per centimeter. Ten species of tolerant caddisflies and fly larvae responded positively to increasing conductivity. The estimates we derive from all three analyses are very close to

the benchmark value of 300 microsiemens per centimeter that was recently set by the U. S. EPA to be protective of Central Appalachian stream biota. Identical analyses were conducted for the sulfate gradient, with results appearing in Table 1 and data and models presented in an appendix."

Q. Very quickly, that mentions sulfates. Can you turn back to page PE 23. Tell me the sulfate threshold that you arrived at.

A. Yeah. So in table 1, we report a TITAN threshold of 50 milligrams per liter, with a confidence interval of 27 to 57. WVSCI also resulted in a threshold estimate of 50 milligrams per liter, with a confidence interval of 48 to 58. So that's where WVSCI on average would fail.

And then the GLIMPSS score resulted in a threshold of 52 milligrams per liter. So very consistent, three different indicators.

Q. Thank you. Now, you mentioned a minute ago that EPA had done some analysis based on WVSCI in their benchmark. Did they actually do any predictions of the probability of failing streams at different WVSCI scores?

A. Yes, they did. They, in fact, used the same dataset and looked at WVSCI scores in those different bins of conductivity and fit a regression model and then used that to predict the probability that a site would fail.

And at 300, their -- their estimated probability was

59 percent of the sites would fail at 300. And then at, I believe, at 500, they predicted that 72 percent of the sites would fail, something like that.

Q. And I just want to direct you to one that is in the benchmark itself. You can turn again to Joint Exhibit 58, the benchmark. This is in actually the first joint exhibit notebook.

Can you turn to page JE 464.

A. Okay. Excuse me. Yes, I have it.

Q. Is that the analysis you were referring to?

A. Yes.

Q. And they looked at it up to a level, it looks like, 500 microsiemens per centimeter.

Did you do a similar type of analysis on the probability of failing WVSCI scores based on conductivity in your work for this case?

A. Yes. So I did a kind of a simple -- I basically looked at percentages of sites that failed in different -- at different levels of conductivity. It wasn't a formal, like a regression analysis. It was simply just tabulating the number of sites that failed in different categories of conductivity.

One of the main differences is that in my report, I had filtered the data heavily to remove sites that had, you know, for example, poor or marginal habitat, low pH, urbanization, a long list of variables that you can propose as confounding

factors. I essentially just removed those data.

And that is very consistent with what the defendants are saying needed to be done to be an epidemiological type of analysis. And in that simple summary, I'm trying -- I can't remember the exact number. I believe it was 53 percent of the sites --

Q. Let's look at it. If you could turn to Joint Exhibit 25.

A. Okay.

Q. Is that the table reflecting the analysis you --

A. Yeah, exactly.

Q. Okay. I think you were about to tell us some of the figures from there.

A. Exactly, yes. So once -- in the group of 301 to 400 microsiemens, after removing many of the sites that had all of these other things that might cause a failing WVSCI score, the percent failure was 53 percent. So, again, very consistent. As we get around 300 and slightly above, we see on average the majority of sites failing.

Q. Okay. And what happens when you get above 1500 conductivity?

A. Above 1500, there were 69 sites, and 67 of them failed, 2 of them passed. It was a 97 percent failure rate.

Q. Okay. We've talked a lot about your work, the work of independent researchers and EPA. Are you aware of any work by the West Virginia Department of Environmental Protection that

looked at responses to macroinvertebrates and conductivity?
A. Well, I mean they have some guidelines about, you know, probable stressors as it relates to conductivity. So I'm not aware of, like, formal analyses necessarily, but they certainly have some specific numerical criteria that relate to how they might go about interpreting impairment or causal results based on, for example, a conductivity value at a site if indeed their WVSCI failed. Is that what you're referring to?
Q. Well, I was asking you if you're aware of things. That is what I had in mind.
If you could, turn to Joint Exhibit 61. Sorry to be switching joint exhibit notebooks. This is in the second one.
A. That's okay. All right.
Q. Can you just read the title of that document?
A. The title is Permitting Guidance for Surface Coal Mining Operations to Protect West Virginia's Narrative Water Quality Standards.
Q. Okay. And if you would turn back one tab to Joint Exhibit 60.
A. Okay.
Q. And can you read the title of this document?
A. Justification and Background for Permitting Guidance for Surface Coal Mining Operations to Protect West Virginia's Narrative Water Quality Standards.

Q. Are these two documents related?
A. Yeah. I mean I believe they are, yes.
Q. Based on the title, it appears that one was justification for the other?
A. Sure.
Q. If you would turn to Joint Exhibit page 700.
A. Okay.
Q. There is a table there looking at cause -- which is listed candidate cause of ionic strength. If you go over in the conductivity column, can you tell me where DEP recognizes that conductivity is going to be a definite stressor?
A. They indicate that above 1533 microsiemens per centimeter, conductivity is a definite stressor, meaning if it's that high, it is, in fact, recognized by the state as not probable but completely definitely a stressor.
Q. Okay. And let's just look at the category below that. Can you tell what they found, you know, below where --
A. Yeah. So from 1075 up to that number, they call it a likely stressor. Then they go down a little bit more, from 700 up to a little over a thousand, and they say it's a probable stressor, and then on down the line.
Q. Now, do you agree with DEP that you need to reach a level of 1075 to be a likely stressor of conductivity?
A. I mean I think that 1075 is more than -- more than a likely stressor at that point. So these are very conservative

numbers.

Q. But would you agree at the top level, I'll assume, that above 1500 --

A. I mean, yeah, the fact that they recognize it, if you're above 1500, the site is definitely stressed by conductivity. I definitely agree with that.

Q. Now, both you and Dr. Palmer have testified about many journals or articles in the peer-reviewed literature that were authored by yourselves and other independent researchers such as Pond.

In your mind is the research in those journals enough to establish a likelihood of causation? And what I mean by that is that a likelihood that conductivity is causing biological impairment.

A. Yes. I mean there has not been a study that has generated results that lead to anything that would lead to any other conclusion other than conductivity being a very consistent, predictable causal factor in the impairment of Appalachian streams.

And, you know, I think one of the things that's been lost in this discussion to some degree is that the scientific method is, in fact, based on consensus in the literature. You know, so causation, I mean there's many things that we consider to be facts of science, you know, evolution, whatever, that are based on our inability to refute a

particular idea or question. And there has been nothing to refute this as a stressor.

And so the body of evidence is what we would consider to be there's very strong inference from all of these papers that lead it to be considered to be there's a consensus in the literature. And when you have a consensus, that's where we get to the point where we say this is a fact of science. Are facts of science occasionally overturned? Very rarely once there's a consensus.

Q. Is it necessary in the field of ecology particularly to run one of these facts of science through a formal causation analysis?

A. I mean when you have this level of evidence and this many studies, that's why, for example, the Scientific Advisory Panel reviewed that benchmark document and all came to the same conclusion, that it was very sound science because of all the steps they had gone through.

You take that and add all the literature that we have on top of it, it's a remarkably strong predictive relationship. So for field data to have this kind of relationship that we see over and over and over again, no matter how we throw our, you know, analyses at it or how people collect the data in different ways, we end up with the same conclusion.

Yeah, it's just a compelling, you know, very clear response that conductivity associated with mine drainage

causes biological impairment.

Q. Let me be clear. Would that be your opinion without looking at any kind of formal causation analysis on conductivity and biological degradation? By "formal causation analysis," I mean the type of thing that might be used by an epidemiologist to confirm a cause of disease.

A. Well, that was done with the benchmark.

Q. But did that need to be done for you to accept this as a scientific fact?

A. No, I think given all the other literature that we have now. But the fact that that was done already in that document just adds -- you know, takes it to the next level. But in general, that's not done in most scientific -- when we're dealing with questions in science.

Science continues to build on issues, and eventually it becomes -- once people study it further and we reach a consensus on what happens, and that rarely is done through a formal causal analysis. It's done by, you know, posing hypotheses, testing them. And when we continue to have an inability to refute a particular hypothesis or a known hypothesis, then we eventually accept something as a fact of science.

Q. And, again, let me be clear. Without a formal causation analysis --

A. Yes.

Q. -- would you accept the causal nature of conductivity to biological impairment as a scientific fact?

A. Yes. So without the benchmark, with all the other literature that is out there now, the consensus is, yes, that this is causing impairment.

Q. Thank you. But as you mentioned, a more formal causal analysis was done.

A. It was done.

Q. And this was done -- was it done in the benchmark?

A. It was done in the benchmark.

Q. If you could, let's just turn to, again, Joint Exhibit 58.

THE COURT: Which one?

THE WITNESS: Yeah.

MR. BECHER: I'm going to go to appendix A, which is in the first joint exhibit notebook. Thank you, Your Honor.

BY MR. BECHER:

Q. Could you just read the heading of --

THE COURT: What page?

MR. BECHER: Oh, excuse me. Joint Exhibit 429. It's the beginning of appendix A.

THE WITNESS: Okay. And you'd like me to read what?

BY MR. BECHER:

Q. Just the heading of appendix A, the title of the section.

A. Okay. Causal Assessment.

Q. Have you read through this section?
A. Yes.
Q. In your mind does this show that through the -- is the method they used in your opinion a valid method?
A. Yes, it is. I mean it's based on the causal analysis decision framework, or CADDIS, that EPA developed 15 years ago. It's based -- which is also further based on Hill's work, Hill's considerations for demonstrating causation. In his case, he was dealing mostly with human health issues, but basically it was adapted and followed it identically.
Q. Do you agree with the conclusions they reached?
A. Yes, absolutely.
Q. Was this causal assessment published anywhere besides the benchmark?
A. It was. So after the benchmark document was published, each of the components -- most of these appendices were published as separate papers in a series of papers in the *Journal of Environmental Toxicology and Chemistry*. And so I believe there's about six different papers, but three or four of them are really key to this demonstrating not only how the method works, but then they go through the formal causal assessment or causal analysis and confounding factor analysis and report the results.
Q. And Dr. Palmer read a bit from one of those papers yesterday. I'm not going to bring you back through that

paper, but can you turn to, again in the plaintiffs' exhibit notebook, Plaintiffs' Exhibit 5.

A. Okay.

Q. I apologize. I'm going to have you do a lot of reading here.

A. That's fine.

Q. Can you tell me what this document is?

A. It's called Assessment Causation of the Extirpation of Stream Macroinvertebrates by a Mixture of Ions.

Q. Is this where the causal analysis for the benchmark was published in peer-reviewed literature?

A. Yes.

Q. Okay. What journal is this published in?

A. It's *Environmental Toxicology and Chemistry*, which is the flagship journal of the Society of Environmental Toxicology and Chemistry, or SETAC.

Q. If you could look at the abstract and the sentence that starts with "Through this assessment." Can you read that sentence and the next two?

A. "Through this assessment, the authors found that a mixture containing the ions calcium, magnesium, bicarbonate, and sulfate, as measured by conductivity, is a common cause of extirpation of aquatic macroinvertebrates in Appalachia where surface coal mining is prevalent. The mixture of ions is implicated as the cause rather than any individual constituent

of the mixture."

Q. Actually, keep going to the next sentence, please.

A. "The authors also expect that ionic concentrations sufficient to cause extirpations would occur with a similar salt mixture containing predominantly bicarbonate, sulfate, calcium, and magnesium in other regions with naturally low conductivity. This case demonstrates the utility of the method for determining whether relationships identified in the field are causal."

Q. And if you could, I want to read the authors' sort of description of what they're doing here. Can you read for me the last sentence on page PE 85?

A. "The evidence is organized by six characteristics of causation: co-occurrence, preceding causation, interaction, alteration, sufficiency, and time order."

Q. Okay. I would like to go through the evidence they looked at in each of these categories as well as how that was weighed.

If you'd turn to page PE 86, the first category they mention is co-occurrence. Can you tell me what they meant by co-occurrence?

A. Well, that --

Q. You can -- actually, they describe immediately below that heading what they're referring to, if that helps you.

A. So I mean do you want -- you're asking me to read it,

then?

Q. Sure, read that.

A. "Because causation requires that causal agents interact with unaffected entities, they must co-occur in space and time."

Q. Okay. And within the category of co-occurrence, they looked at a couple of different subcategories of evidence. The first one appears below that.

Can you tell me what they first looked at with co-occurrence?

A. Co-occurrence between conductivity and extirpation of genera.

Q. Okay. And within that, they tell how they score this evidence in a paragraph beginning "Scoring." Can you read from that paragraph?

A. "This evidence supports the causal relationship; extirpation of 40 genera in West Virginia and 46 in Kentucky in streams with conductivity greater than 1500 microsiemens per centimeter is a strong effect. The two independent data sets and analyses corroborated one another. The total score is assigned plus, plus, plus," which is the highest score that it can receive for being a causal factor.

Q. And can you tell me why -- what the meaning of "plus" is here?

A. "Plus" relates to -- I mean they had multiple lines of

evidence that they looked at in scoring this, and each one received a very strong score, meaning the relationship was very strong in terms of co-occurrence, and cumulatively that results in the highest score.

Q. Could they alternatively have a minus for a category?

A. Absolutely, or none and no weight. No weight means it's equivocal or it didn't apply.

Q. And in addition, they could have, you know, two minuses or three minuses as they're having two or three pluses?

A. That's right. So if you have a -- basically if you have a minus, it almost immediately rules out something as a causal factor.

Q. Okay.

A. So, for example, in Kentucky there was, you know, like one genera that was extirpated with conductivity. They would probably score it as, like, a minus or very equivocal effect, which would almost rule it out. But since they had found the identical thing there, it got to be a very high score.

Q. So here again we have three pluses for this type of co-occurrence with extirpation of genera.

A. That's correct.

Q. What about the co-occurrence of cause and Ephemeroptera? That's the next category. The score actually appears on page PE 87. Can you read for me that paragraph?

A. Yes. "This evidence supports the causal relationship

between conductivity and extirpation of genera. Where conductivity is high, individuals of the order Ephemeroptera are less likely to occur. A change of 50 percent or more is large. The evidence is corroborated in three independent data sets collected from different streams at different times by different researchers using different sampling protocols. The total score assigned is plus plus plus."

Q. Okay. And what is the next subcategory they looked at?

A. Co-occurrence in nearby catchments.

Q. And their score for that appears on PE 88. Can you read that score, the text that goes along with that score?

A. Sure. And I think it's worth noting that the co-occurrence in nearby catchments, the catchments that they examined were Boardtreee and Stillhouse Branch and Ash Fork in the Twentymile Creek watershed. So they specifically were looking at the site in question here and the scoring.

"This evidence supports the causal relationship; the number of genera is two to three times greater at the low-conductivity sites for most metrics; few or no Ephemeroptera were observed at three-fourths of the sites. The results are consistent and independently corroborated. Total score assigned is plus plus plus."

Q. And next we've got an entirely new category, Preceding Causation. Can you tell me what preceding causation is either in your own words or by reading what they wrote?

A. Well, I think in this case they're referring to, like, a source; for example, alkaline mining. You know, the mine itself leads to a specific mixture of ions. And then they look at it in contrast to other sources and types of ions to make sure that there are not other sources that could lead to the same mixture of ions.

It's more like a pathway; is there a causal pathway from something to the stressor and the causal agent? And that's my understanding of what they mean there.

Q. Thank you. And the first subcategory is complete source-to-cause pathway from the literature. Can you read for me the scoring for that?

A. "This evidence from the literature indicates that there are sources of the mixture of dissolved ions that are widespread in region and can be differentiated from sources of other mixtures. Multiple studies are consistent in the description of the ion types associated with different sources." Strength is not scored here. The total score is plus plus.

Q. So we don't get three pluses there, but we get two.

A. Yeah.

Q. All right. The next is the co-occurrence of sources and conductivity from the region. Can you read me the scoring for that?

A. "This evidence supports the causal relationship. The

conductivity at mined sites is 10 to 50 times greater than at unmined sites. The source of increased conductivity is independently corroborated and consistent. Total score is plus plus plus."

Q. Okay. And the next subcategory appears after that, characteristic composition of identified sources. Can you tell me the scoring for this subcategory?

A. "The evidence supports the causal relationship by showing that there are sources of high conductivity with a consistent matrix of ions. Both mined and unmined sites have similar proportions of calcium, magnesium, bicarbonate, and sulfate but very different concentrations. The difference between the ionic composition of mined watersheds and watersheds with other sources of ions such as brines," sea salt, "is very large. The evidence from the West Virginia database and two other Appalachian studies consistently supported the ionic makeup associated with land disturbance, especially surface mining. The data from mined and unmined watersheds are from a peer-reviewed publication, and the brine values are from reports from extraction permittees in West Virginia. Although the brine analyses are not peer reviewed, the findings are qualitatively similar to other non-peer-reviewed reports of the makeup of such brines. Total score is plus plus plus."

Q. And the next subcategory we have is correlation of conductivity with sources. Can you read me the score for

that?

A. "This evidence supports the causal relationship. The correlations for percentage area in mountaintop mining with valley fill, all mining minus valley fill and abandoned mine lands, and forestry are moderately strong based on our a priori scoring system. The present study has not been independently corroborated, although it is consistent with the findings of Pond et al. and Lindberg at al. The association seems to be specific for extensive geologic disturbances, which in these regions are from mining and valley fills. The total score is plus."

Q. Okay. We get next to a new category, interaction and physiological mechanisms. Can you tell me what is interaction and physiological mechanisms referring to? Again, they describe it, if it helps you to read there.

A. Yeah. I'll just say, "Causal agents alter affected entities by interacting with them through a physical mechanism. Evidence that a mechanism of interaction exists for a proposed causal relationship strengthens the argument for that relationship."

Q. The first category under that is evidence of mechanism of exposure. Can you read me the score?

A. "Evidence of a mechanism of exposure is from knowledgeable -- is from knowledge that the ions are present in streams and from general knowledge of animal physiology and

the anatomy of insects and other aquatic invertebrates. Because the exposure is by the same mechanism that provides respiration (that is, the maintenance of water flow over permeable membranes), it is strong. Many studies support this inference. The total score is plus plus plus."

Q. Okay. The next subcategory, biochemical mechanisms of effect, can you read me the scoring?

A. "This mechanism supports the causal relationship by providing evidence that the bicarbonate ion matrix in the region can create ionic gradients that interfere with proper homeostasis. However, direct observations of the ionic regulatory processes or membrane potential measurements are not described in the literature for affected or tolerant species studied in Appalachia. Evidence from the literature about mitochondrion-rich chloride cells in epithelia of insects, (particularly in mayflies), amphibians, and fish, logically leads to disruption of ionic regulation in organisms highly dependent on passive ionic regulation by a bicarbonate chloride antiport anion exchange. Other ion transport systems are also affected by increases in the concentration of the ion mixture, which is measured as increased conductivity in the region of concern. A large body of peer-reviewed physiological studies supports this inference. The total score is plus plus."

Q. Okay. And the scoring for physiological mechanism of

effect?

A. "This evidence supports the causal relationship by demonstrating that the loss of ionic regulation can affect an animal's physiology leading to severe effects. Studies of the physiology of affected species and intolerant species from Appalachia are not available. The effects of ionic disruption are supported by a large body of peer-reviewed physiological studies, some of which are presented above. The total score is plus plus."

Q. Okay. Next we have a new category, alteration. Can you read the first sentence describing what alteration means?

A. Yes. "A cause alters or changes a susceptible entity. In this case, the alteration is failure to maintain viable populations of sensitive species."

Q. Okay. And the first alteration we looked -- the type of alteration, the first subcategory is the change in genera. Can you read the scoring?

A. "This evidence supports the causal relationship by demonstrating that conductivity greater than background levels causes a consistent set of sensitive genera to be extirpated. The number of genera with similar extirpation concentration values (less than 10 percent difference) in Kentucky and West Virginia with extirpation concentration values less than 500 microsiemens per centimeter is 71.4 percent and for those with a similar pattern of decline, it is 81.5 percent. Multiple

studies and data sets confirm this evidence. The total score is plus plus plus."

Q. Next, we have as alteration models, change of genera. Again, can you read me the score?

A. "This evidence supports the causal relationship by demonstrating that conductivity greater than background levels causes a consistent set of sensitive animals to be extirpated. The prediction was statistically strong. The effect is specific enough to clearly separate groups by nonparametric statistical methods into two different data sets. Independent data sets and investigators confirmed that different assemblages of invertebrates occur with different stressors, including neutral-to-alkaline waters with increased concentration of ions. The total score is plus plus plus."

Q. Okay. We get to a new category of sufficiency. Can you read the first two sentences where they describe what they are talking about when they're referring to sufficiency.

A. Well, "Because many agents are natural components of the environment (for example, ions), a causal relationship must show that there are thresholds or patterns of the effect to the susceptible entities (for example, mayflies) associated with the changing magnitude of exposure (for example, conductivity). In this section, we describe evidence that can be credibly used to evaluate whether the level of ionic concentration is sufficient to cause extirpation."

Q. Now, read for me the title of that first category under Sufficiency.

A. "Laboratory tests of reconstituted mine discharges."

Q. Okay. Was the benchmark largely derived using laboratory data?

A. No.

Q. Okay. So if you could, read for me, so we get a clear idea of how they're using laboratory data, read for me not only the scoring but that whole section.

A. All right.

Q. It's a short one.

A. Starting with "Kennedy" there?

Q. Yes.

A. "Kennedy et al. tested simulated coal mine discharge waters in Ohio with the ephemeropteran *Isonychia bicolor*. The ionic matrix was dominated by sulfate, bicarbonate, and sodium. In 7-day lethality tests, the lowest observed effect concentrations for survival of *Isonychia*" -- and these were mid-to-late instars -- "at 20 degrees Centigrade occurred at 1,562, 966, and 987 microsiemens per centimeter in three tests. These values bracket the field-derived extirpation concentration for *Isonychia* of 1,180 microsiemens per centimeter."

Q. Thank you. And can you read for me the scoring under that section.

A. "The laboratory tests by Kennedy et al. establish that the effect for one insensitive ephemeropteran species, *Isonychia bicolor*, in the laboratory, occurred at a similar conductivity level to that in the field. A total score of plus was assigned."

Q. Okay. Before I miss it, there was one sentence there at the end that you did not read that refers to a difference in temperature. Can you read that for me?

A. "However, when the assay was conducted at 12 degrees, the lowest observed effect concentration was 4,973, suggesting that longer exposures are needed before effects occur at cold temperatures."

Q. Okay. Now, are they -- they're reviewing another author's work, Kennedy; is that correct?

A. Yes.

Q. Are they interpreting Kennedy to say that temperature is causing the impairment here?

A. No.

Q. Okay.

A. I mean they're simply saying that at a cold temperature of 12, physiologically the organism is -- basically its metabolism is much slower and the effect would probably take longer to be realized. The organism is developing slower. Everything is slower. So it's sort of like the movie reel is moving slower. That's all.

Q. The next category we'll look at is field exposure-response relationships of composite metrics.

The scoring for that appears on PE 92. Can you read that for me?

A. "The field observations show that as conductivity increases, the number of Ephemeroptera and total number of genera decrease and, thus, the concentration of ions in streams is sufficient to cause effects. The correlation is strong to moderately strong depending on the data set. The effect was specific for the ionic mixture. The correlations were corroborated with independent data sets from different streams sampled by different investigators. A total score of plus plus was assigned."

Q. Okay. The next is field exposure relationships of composite indices.

Can you tell me which indices this is referring to and then read the scoring?

A. Yes. They're referring to the WVSCI score here, and the scoring, "This set of evidence indicates that, in multiple data sets and by a variety of biological responses and analytical methods, as conductivity levels observed in the region increase, stream condition decreases, and the assemblage of macroinvertebrates is different from best available reference sites in the region. This is supporting evidence of sufficient ionic concentrations in the streams to

cause widespread effects. The correlations are strong. The correlations were corroborated with different methods in four independent studies. A total score of plus plus plus was assigned."

Q. Okay. And the last in this category is field exposure-response relationships: susceptible genera. Can you read the scoring there?

A. "The observed effects logically support the causal relationship between increased conductivity and declining occurrence of susceptible genera and indicate that effects occur at relatively low conductivity levels. The effect is strong, with complete extirpation of many genera. The results were corroborated with independent data sets from Kentucky and Virginia. The total score is plus plus plus."

Q. Okay. The last major category they have is time order. Can you read for me what they mean by time order?

A. Well, "Logically, a causal event occurs before an effect is observed. Evidence of time order could be provided by changes in the invertebrate assemblages after the introduction of a source that increased conductivity.

"We could not obtain conductivity and biological survey data collected before and after construction of a valley fill or release of ion-rich effluents from other sources. Hence, this characteristic of causation is scored as no evidence," because they didn't have any.

Q. Okay. So they didn't have any pre-mining data?
A. Apparently not.
Q. Now, this analysis you now read very carefully, are they just using the -- just looking at their own work and the benchmark to do this causal analysis?
A. I mean, very clearly, no.
Q. And was there any evidence that they found that pointed to a non-causal effect?
A. No.
Q. What would you say was the most common score given here?
A. The highest, you know, the plus plus plus. Basically that's unequivocally strong causal evidence.
Q. Okay. Would you agree with this analysis?
A. Yeah. Yes, I would. They outline -- they're very thorough and they have multiple lines of evidence, and absolutely.
Q. Thank you. Now, as part of their causal analysis, did they also look at confounding factors?
A. Absolutely.
Q. Was that done in a separate paper? Do you know?
A. Yes, it was.
Q. I'd like you, if you could, turn to Plaintiffs' Exhibit 8. And can you read for me the title of Plaintiffs' Exhibit 8?
A. "A Method For Assessing The Potential For Confounding

Applied" -- let me start over. "A Method For Assessing The Potential For Confounding Applied To Ionic Strength In Central Appalachian Streams."

Q. Was this work from another -- I believe you said earlier that these publications were largely taken from work done in the appendices of the benchmark.

Is this true of this paper as well?

A. Yes.

Q. Okay. I want to actually refer to the work in the benchmark in a little more detail. Before we get there, can you read in the published document, in the abstract, the sentence that begins "Twelve potential confounders."

A. "Twelve potential confounders were evaluated: habitat, organic enrichment, nutrients, deposited sediments, pH, selenium, temperature, lack of headwaters, catchment area, settling ponds, dissolved oxygen, and metals."

Q. And that describes, if you need a moment to look, the analysis done in this paper and in the benchmark to your knowledge?

A. Yes.

Q. I want to very quickly read the general approach they took under the methods. If you could, it's on the same page. The first two sentences under General Approach.

A. "We developed a weight-of-evidence approach for evaluating potential confounders. Both logical arguments and

statistical analyses are used to indicate whether an environmental factor affects or does not affect our ability to model the causal relationship. If the body of evidence indicates that the factor was not a potential confounder, no action was taken."

Q. Why don't you go on to read to the end of that paragraph.

A. "If the body of evidence indicates that environmental factor was a likely confounder, then the data set was truncated to reduce the effect of the confounder." That is, they threw out data that might confound. "Truncation removes the observations for which the confounder was beyond its threshold for effects. Although it was not necessary in this case, other methods might be used to adjust for any discovered confounding of the causal relationship."

Q. Is that similar to the approach you took in filtering data in your "How Many Mountains" paper?

A. Exactly.

Q. Now, they provided a little more detail in this paper and the benchmark. So I want to refer, if I could, to benchmark appendix B, which is the first joint exhibit notebook. Again, it's Joint Exhibit 58.

A. Okay.

Q. And actually first go to the first page of that appendices or the appendix, Joint Exhibit 472, page 472.

A. Yeah, I'm there.

Q. Okay. This shows this appendix is, as you said, the analysis of potential confounders?
A. Yes.
Q. Okay. I don't want to go through each one. As we said, there are 12. But generally is the method they used to look at confounding similar to the weight of evidence approach they used for causation?
A. It's similar, yes.
Q. I want to look at how they analyzed two of the specific potential confounders. If you could, turn to page JE 493.
A. Okay.
Q. And we see a table with, this time, minuses. The last time we were looking at pluses, which I believe you said indicated causation. What do these minuses mean?
A. Well, minuses mean that this is not likely to be a confounder. So if they had a plus, then it basically is indicating evidence they may be confounding.
Q. Okay. And they looked at -- well, how many different categories did they look at to determine whether temperature was a confounding factor? And that's -- it's all listed on table B-20 on that page, 493.
A. Here we go. It's labeled 1, 2, 3, 5, 6, 7. So there's actually six, unless one of them has -- I don't know how that numbering works.
Q. I hadn't noticed that before. Can you read through those

six --

A. Sure.

Q. -- types of evidence they used?

A. So first is correlation of cause and confounder, and it received a score of zero. Temperature was moderately correlated with conductivity year-round in the West Virginia dataset, with an R of .39, but was weakly correlated in the EPA dataset. So that one received a score of zero.

So number 2, correlation of effect and confounder. So in this case, they're looking at the response of mayflies to temperature.

Temperature was weakly correlated with Ephemeroptera year-round in the West Virginia dataset and uncorrelated in the EPA dataset.

Number 3, contingency -- and that received a score of minus.

Contingency of high level -- of high level of cause and confounder. Okay. So Ephemeroptera were present at 99 to 100 percent of sites that had low conductivity at both high and low temperature. In the high conductivity categories, Ephemeroptera occurred in more sites with elevated temperatures, which is contrary to expectations if temperature were contributing to the impairment.

I believe it was like 56 percent of the sites at high temperatures versus 33 percent, or something like that, at

low. So that received a score of minus minus minus.

So the next one, 5, levels of confounders known to cause effects. Temperature limits are highly taxon specific, but temperatures rarely exceeded the West Virginia limits for reference sites, which is 30.6 degrees Centigrade May through November and less than 22.8 degrees Centigrade December through April.

Q. I want to stop you there for a moment. What does that West Virginia limits for reference sites of 30.6 mean?

A. It means that a site cannot be classified as a reference site if temperature exceeds 30.6. So the state recognizes 30.6 as a threshold where you're likely to see, for example, effects on mayflies.

Q. Thank you.

A. And so they scored this a minus.

The next point, removal of confounders shows it is important. When high temperatures were deleted, the correlation of conductivity and Ephemeroptera was unchanged, with a negative .61 correlation. Minus minus.

Then lastly, multivariate statistics. Habitat quality, temperature, and fecal coliform together had essentially no effect on the slope in multiple regression.

So when they added in other factors on top of temperature, they didn't see a change. So that's minus minus.

And so the weight of evidence received a total score of

minus minus, almost the highest score it can receive, moderately confident, none positive, some strongly negative. No treatment for confounding.

Q. Okay. And you yourself in preparation for this case had done some looking at potential response of temperature and mayflies as they did here, did you not?

A. I did.

Q. If you could, we're going to go to the -- actually, it's the same notebook. Joint Exhibit 32.

And what is this graph?

A. Okay.

Q. First of all, where did it come from?

A. Well, these are data that represent a subset of data from the "How Many Mountains" paper, which was 223 sites that had already been filtered for several variables.

What I did is I further screened that dataset to remove samples that occurred during the spring, because to include an analysis of temperature versus mayflies over the course of, you know, March through August, temperature is going to be changing rapidly in the spring.

In the summer, it tends to level off. And even you can see in Dr. Menzie's work where he looks at temperature. You see relatively similar temperatures, at least a range of temperatures that's fairly flat.

So the goal here was to say, okay, here's the summer.

This is when things are going to be the warmest, and this is where temperature is most likely to be a confounding factor.

So I looked at the number of mayfly taxa that occurred at these sites; and it was roughly, I think, 133 sites that came out of the 223. And the relationship shows, even though I've drawn a regression line through this just to show -- it's really just a trend line. I wouldn't want to try to say that this is some sort of valid statistical relationship, because it's not.

What I'm showing here is that as you go from low temperatures -- so we've got some as low as around 12 degrees -- all the way up to levels around 28 degrees Centigrade, you find a similar range of mayflies, okay?

So mayflies are, as Dr. Menzie has said in the past, the group that mostly drives the WVSCI response. And here we have mayflies occurring at similar levels across all temperatures that are measured in this dataset.

So as I've said in the past, I don't think temperature -- snapshot temperature data from this kind of dataset are very reliable in the sense that they're telling us that, you know, you just see a value of -- for example, I see a value of 18. I don't have a lot of certainty that that represents the thermal regime at that site. But when I see a value of 28, that means that that's a site that likely consistently gets pretty warm, okay? You can't have a high value and -- I mean

it wouldn't just blip up like that and never come back to that level.

So high value, you've got high value, yet we still see up to 10 mayfly taxa at a site near 28 degrees C. So seeing this result alone tells me that in addition to all the other stuff the EPA has done, to say that temperature is really -- might be the confounding behind-the-scenes like leading to all these changes, is ridiculous.

Q. I want to ask you one thing here I want to clarify. Will you look at the labels you have for the axes? Are those correct?

A. No. I don't know how that happened.

Q. Can you tell us what they're supposed to be?

A. Yeah. The X axis is supposed to be temperature, and the Y axis is the number of mayfly taxa. So --

Q. X would be horizontal?

A. What's that?

Q. X would be horizontal?

A. Yes. The horizonal axis is temperature in degrees Centigrade, and the X axis is the number of mayfly taxa. I don't know how that happened, but thank you for pointing that out.

Q. Let's move back a tab to Joint Exhibit 31.

A. Okay.

Q. And what does this graph represent?

A. So this is the same 133 sample points just from summer. So they also have just a snapshot of conductivity. And it is the relationship -- again, this case, it says specific conductivity, and the Y axis's number should say number of mayfly taxa. And the relationship that you see is basically a very sharp, non-linear decline in the number of mayfly taxa as conductivity increases. The relationship is strong.

Again, I fit a trend line here just to give you an idea of how strong it is. But the bottom line is, if you contrast this graph with the preceding graph, the one we just looked at, it's fairly clear that even though this is snapshot data, a one-time measurement of conductivity, when you have a high conductivity value, that's indicative of a site that probably is affected by alkaline mine drainage, and we don't find mayflies there.

We have a high-temperature site, which is a site that likely is affected to some degree by high temperatures. We're just as likely to have lots of mayflies there as we are at a low-temperature site.

So I guess if I saw this graph, but it was -- the relationship was like this for temperature, I would be willing to say, yeah, I think temperature is a confounding factor, but --

Q. It's clearly not.

A. It's clearly not like that at all. So I mean I would be,

like, there's clearly something going on here and at a minimum we need to consider temperature as a confounding factor if it looked like this. But it doesn't look anything like this.

Q. All right. Thank you.

MR. HARVEY: Your Honor, whenever there's a good breaking point, counsel could use a comfort break.

MR. BECHER: I'm going to transition to a new topic. So this is --

THE COURT: All right. We'll take a ten-minute recess.

You may step down. Don't discuss your testimony.

(Recess from 10:28 a.m. to 10:45 a.m.)

THE COURT: All right. You may resume.

MR. BECHER: Thank you, Your Honor.

BY MR. BECHER:

Q. I believe when we left off, we'd gone through the benchmark analysis of the confounding factor of temperature. I want to go through next the treatment for deposited sediment. If you could, turn to Joint Exhibit 486.

A. Joint Exhibit page?

Q. JE 486.

A. Okay.

Q. Can you look at table B-14 for me?

A. Okay.

Q. Is that the weight of evidence analysis they did for the confounding factor -- potential confounding factor of deposited sediment?

A. Yes.

Q. Can you read through that table for me?

A. Okay. Number 1, correlation of cause and confounders. So this would be conductivity versus embeddedness, which was the metric of deposited sediment.

The West Virginia embeddedness score was weakly correlated with conductivity. So it received a score of minus.

Okay. Correlation of the effect; that is, the number of mayflies. And the confounder; that is, embeddedness. The embeddedness score is weakly correlated with Ephemeroptera. It received a score of minus.

Contingency of high level of cause and confounder. In a contingency table, see table B-13, high embeddedness scores, that is, greater than 15, which is in this case a good frame they score it. So meaning 15 is low. And actually it doesn't have that high of embeddedness.

Q. Thank you.

A. "Has little effect at either high or low conductivity."

Q. Okay. And the last?

A. Removal of confounder. "When samples within an embeddedness score less than 13 are removed from the analysis,

the correlation of conductivity with the number of Ephemeroptera was virtually unchanged."

So they removed scores that were less than 13, which is, actually -- you know, 10 to 13 is still considered to be in the suboptimal, which isn't necessarily bad; removed all the samples that had embeddedness scores from zero to 13, and it had no effect on the relationship between conductivity and mayflies.

Q. So what was their overall score for this weight of evidence approach?

A. Three minuses. They were very confident, all negative, some strongly. No treatment for confounding.

Q. Okay. And do you think this is a -- do you agree with this method for analyzing the confounding factor, the potential confounding factor of deposited sediment?

A. Yes, I do. I mean I think they looked at it in multiple ways, and it's pretty clear that the relationship between conductivity and mayflies is not -- it's not being modulated or influenced by embeddedness, nor is it being caused by embeddedness.

Q. Thank you. Now, you have read, I believe, a reference in Cormier and Suter's paper, did the one on causation to a laboratory study. Do you remember that?

A. I do.

Q. Were there any other laboratory studies besides the

Kennedy paper reference there that you know of?
A. There's a paper by Kunz et al., Kunz, where they --
Q. If you could, let's turn to Plaintiffs' Exhibit 10 in the plaintiffs' exhibit notebook, not the joint exhibit.
A. Okay.
Q. Is that the Kunz paper you were referring to?
A. Yes, it is.
Q. And in the abstract, there is a sentence that begins with "Two of the reconstituted waters." Can you read that sentence for me?
A. "Two of the reconstituted waters had ionic compositions representative of alkaline mine drainage associated with mountaintop removal and valley fill-impacted streams." And there it names Winding Shoals and Boardtree. They had elevated magnesium, calcium, potassium, sulfate, and bicarbonate, and a third reconstituted water had an ionic composition representative of neutralized mine drainage, that is, Upper Dempsey, with elevated sodium, potassium, sulfate, and bicarbonate.
Q. Are you familiar with the location of Boardtree Branch?
A. Yes. It's just to the west of Stillhouse Branch.
Q. About how far?
A. I mean it's immediately -- it's the next watershed over. I mean the watersheds come in contact with each other.
Q. If you could, turn to later in that article, page PE 144.

A. Yes.

Q. If you look at table 2, can you tell me what table 2 represents?

A. Sure. In table 2, they outline the three different sites and -- you know, in rows. And within those three sites, they have the different types of water that they analyzed, whether it was the full-strength reconstituted water or diluted water, for example, 10 percent or 50 percent strength.

And then the data in the table represent the survival and either, like, the number of offspring or the growth of the organisms exposed to these different types of waters. And there are four different types of organisms, the cladoceran, which is a standard *Ceriodaphnia*. Then they use a freshwater mussel, unionid mussel, which is really a neat application because it's not a standard, but it is a stream-dwelling organism.

They also used an amphipod *Hyalella azteca*, which is a standard ecotox model organism, and then also used a mayfly. And this is also -- this is the non-standard ecotox model organism. It's one that this particular lab has been using. It's called *Centroptilum*, and it turns out as one that occurs frequently in streams in Appalachia.

Q. What is -- if you could, I know that they've got amphipod, and then they give the scientific species name. Can you tell us in layman's terms what an amphipod is?

A. An amphipod is a -- oh, a layman's name would be a scud or a sideswimmer. It's a little crustacean, a shrimp-like organism that's probably no bigger than your fingernail on your pinky.

Q. And let me back up for a second to be clear. Were these tests done in the field or in a laboratory?

A. These are laboratory tests.

Q. Okay. I want you to focus in on the results for the mayfly.

A. Okay.

Q. Can you just briefly first tell me what they found with the mayfly, and then read for me the results as they appear in the chart.

A. Okay. Well, they measured survival in terms of the percentage of individuals and the biomass of the mayfly. And this was a 35-day test. So it was the entire lifespan of the immature. So from right when they hatched, they took the early instars and subjected them to the different mine waters and controls. And they grew them for 35 days, all the way until emergence when the mayfly actually becomes an adult winged organism and flies.

And what they found was at Winding Shoals and Boardtree, the controls have 84 and 80 percent survival. And the biomass had -- was 8.5 and 8.9, on average, milligrams per individual. So that's control water. So it's basically reconstituted

water that lacks these ions or at least very low concentrations.

Then they looked at the mine water, and they had -- at Winding Shoals, they had --

Q. Well, let's just focus on Boardtree.

A. Okay. Well, they took Boardtree and they looked at full-strength water and 50 percent diluted water. And at full-strength water, no mayflies survived. And at 50 percent diluted water, 37 percent survived. And the ones that did survive only weighed 3.7 milligrams. So they were less than half the mass or size of the ones that were in the control water.

Q. Thank you. If you could, turn in the same exhibit to page PE 148.

Now, if you could, read for me the sentence that appears in the middle paragraph in the first column and begins with "The Winding Shoals and Boardtree reconstituted waters."

A. Okay.

Q. It's most of the way down the paragraph.

A. All right. "The Winding Shoals and Boardtree reconstituted waters were toxic to *L. siliquoidea*, *H. azteca*, or *C. dubia* at conductivities ranging from about 500 to 2400 microsiemens per centimeter. The Upper Dempsey reconstituted water" --

Q. Okay. Excuse me. I actually want you to go in the

paragraph before that. Sorry for not directing you well. It's actually the sentence towards the end of that paragraph that's talking about the *triangulifer*.

A. Yeah. There's another sentence that starts exactly the same. My apologies. So at this point you're referring me back just a few sentences up in that paragraph, correct?

Q. Right.

A. "The Winding Shoals and Boardtree reconstituted waters were toxic to *C. triangulifer*," which is *Centroptilum*, the mayfly, "at a conductivity of about 800 to 1300 microsiemens per centimeter with elevated concentrations of magnesium, calcium, sodium, potassium, sulfate, or bicarbonate. It is interesting to note that the regional 95 extirpation concentration based on conductivity for the *Centroptilum* in the benthic community field surveys was determined to be 1092."

And in this case, they're referring directly to the benchmark document and those papers.

"However, the genus *Centroptilum* was not among the more sensitive taxa used to derive the regional benchmark." That is, 56 of the native taxa had extirpation concentration values that were less than that of *Centroptilum*."

Q. So are they saying here that the results they found in the lab were similar to the results that were measured by field data?

A. Yeah. Basically the field value fell right in the middle of the range that they found in the lab for *Centroptilum*, yes. And it's also noted that it's, you know, one of the more tolerant species, and they end up with a value that is pretty high, but, again, it was high in the field as well.

Q. And next, if I could switch over to the next column, the last paragraph there where it's talking about the ionic composition of Winding Shoals and Boardtree reconstituted waters. Can you read that sentence? It's about two-thirds of the way through that last paragraph.

A. "The ionic composition of the Winding Shoals and Boardtree reconstituted waters are characteristic of mountaintop-mining-impacted streams, and *C. triangulifer* is representative of native Appalachian taxa, albeit more tolerant to elevated conductivity based on benthic community survey data. Future studies should focus on identifying the" --

Q. That's fine.

A. Okay.

Q. Thank you. I want to move on to some of the site-specific evidence we have in the case. Let's first talk about biological impairment.

I believe that Dr. Palmer testified yesterday that Stillhouse Branch was recognized by the West Virginia DEP as biologically impaired. Do you recall that?

A. Yes, I do.
Q. Do you know if this impairment extends down to the next order stream, Twentymile Creek?
A. Twentymile Creek I believe is impaired, yes.
Q. Okay. If you could, turn to Joint Exhibit 53. Can you tell me what this document is?
A. It's called Total Maximum Daily Loads for Selected Streams in the Gauley River Watershed, West Virginia.
Q. And are you familiar with total maximum daily load?
A. Yes.
Q. Can you just briefly and generally describe what TMDL, the total maximum daily load, is?
A. Well, it's basically a watershed-specific like a management plan for a specific type of like a sediment or a nutrient or something along those lines. It's essentially how much can go into that system.
Q. Why do they do it?
A. They do it to limit impairments because there's usually an impairment of some type in a water body; and they basically start restricting something so that they can restore it or at least get it so that it is not classified as being impaired.
Q. If you turn to, in that exhibit, JE 235, please. This is table 3-3. What is this table? Just read the heading there.
A. "Water bodies and impairments for which TMDLs have been

developed."

Q. Okay. Can you move over two pages to JE 237, please?

A. Okay.

Q. Can you tell me the recognized impairment for Twentymile Creek itself?

MR. HARVEY: Your Honor, same objection as yesterday. There's no claim here against Twentymile.

THE COURT: Was there no reference in the reports to Twentymile Creek or conditions there?

MR. BECHER: One minute, Your Honor.

Your Honor, I believe the objection yesterday was different. The objection yesterday was it was outside the scope of cross.

This is direct, and I think Mr. -- or, excuse me -- Dr. King has testified about the extent and the type of biological degradation downstream from valley fills. We just want to show how far this one is extending.

THE COURT: Well, I disagree. I took yesterday's objection to be both that it wasn't -- it was beyond the scope, meaning that you all didn't -- the defense didn't do anything to elicit testimony about Twentymile Creek and that the expert hadn't indicated opinions or findings relative to Twentymile Creek as part of their report. And that's the way I take this objection.

So if it's not somewhere in his report or in the findings

that the expert has referred to, then I don't think you can get into Twentymile Creek. I know that Stillhouse feeds into it. Obviously you can have him testify about how Stillhouse Branch is characterized under the 303(d) list, but not beyond that.

MR. BECHER: Your Honor, I would point out, if you turn to the stipulation, the facts that we had agreed upon and filed with this Court, we do have a stipulation --

THE COURT: Where is that?

MR. BECHER: It's Joint Exhibit 43. That not only Stillhouse Branch but Twentymile Creek is impaired.

THE COURT: What paragraph?

MR. BECHER: It's page JE 129.15.

THE COURT: Did you say which paragraph?

MR. BECHER: 15. "Both Stillhouse Branch and Twentymile Creek downstream of that branch" --

THE COURT: All right. Well, it's clear that Twentymile Creek is listed as impaired. The stipulation goes no further than that. I'm not going to let you get into testimony or opinions about whether the impairment of Twentymile Creek is related to or caused by Stillhouse. It doesn't seem to me that it would matter either way.

MR. BECHER: That's the only point I wanted to make, Your Honor. Thank you.

THE COURT: Fair enough.

BY MR. BECHER:

Q. I'm making this difficult on myself. Have you looked at the chemical data for Stillhouse Branch in this case?

A. Yes.

Q. Will you turn actually to the same exhibit I was speaking with the judge about, Joint Exhibit 43.

A. Okay.

Q. At point 9 -- it's on the second page of the stipulation -- there's a chart of conductivity and sulfate. Can you tell me what that chart represents?

A. This is baseline data prior to the mine. So this is in the mining permit application. And at the mouth of Stillhouse Branch, they have six conductivity and sulfate measurements, as they did it six times over -- these are monthly samples.

Q. I don't need you to read all of them, but can you tell me generally --

A. Yeah. Well, the range is 47 to 104 microsiemens per centimeter conductivity, and 4 to 22 milligrams per liter sulfate.

Q. In your opinion -- you said this was baseline data. Is this the kind of pre-mining data that Cormier and Suter were missing in their causation analysis?

A. It is. I mean, it is.

Q. Let's see what happens. Can you turn to the chart under point 11.

A. Okay.
Q. And what does this data represent?
A. These are samples that begin in July 1998 following construction of the mine, and that's also conductivity and sulfate data that's taken it looks to be almost weekly. Well, they have one value in 1998, and there's mostly weekly data starting in 2003.
Q. Okay. And what has happened to the conductivity and sulfate levels here?
A. Well, I mean 1998, right after the mine was constructed, it had jumped up to 511. And then by 2003, the values were, for example, 3794. Most of them are two to three thousand here. Yeah, pretty consistently in the two to three thousand range, with sulfate levels in the one to two thousand milligrams per liter range.
Q. How does that compare with the pre-mining data?
A. It's -- you know, in order of magnitude increase, it's very different. So pre-mining data at this site looked like an unimpaired reference stream in terms of the -- at least for those two.
Q. Actually, in most cases it's two orders of magnitude; is that --
A. Yeah. Yeah. Sulfate for sure.
Q. Also if you turn to JE 129.16, there's another chart.
A. Okay.

Q. And what does this data represent?
A. This is more discharge data from the mine.
Q. I want to be clear. This is -- clearly it says discharge data from Outlet 29. The previous chart we looked at, was that discharge data or in-stream data?
A. I thought it was actually at the outlet of the stream. At the mouth of Stillhouse Branch, yes.
Q. So 11 was at the mouth of Stillhouse Branch, and 16 is from the outfall --
A. That's right.
Q. -- from the mine. And are those numbers fairly consistent?
A. Yes, they are. They're all -- most of them are in the two to three thousand range. There's one value of 763. Interestingly, one had dropped all the way to 307. That's illustrating how occasionally during rain events you can have massive dilution; and if you take a snapshot into the conductivity value, that's a source of some of the noise in our analysis.
Q. And so this again is showing in sort of a time order sequence that conductivity as a result of mining is drastically increased in Stillhouse Branch.
A. Yeah. Yes.
Q. Let's look at biological data next. If you could, it's in the second joint exhibit notebook. Turn to Joint Exhibit

62.

MR. HARVEY: Objection, Your Honor. It was pretty clear in the deposition that Dr. King had not reviewed this data. I asked him if he had any -- reviewed any pre-mining data. He said no.

Mr. Lovett placed the data in front of him and said, "Do you remember this data now, Dr. King?" And he said, "Oh, yes." He reviewed it during his deposition and then commented on it. It was not part of his expert report in any way.

MR. BECHER: This was -- he was deposed on this document, and he did in his expert report refer to conductivity tolerances with individual taxa, which is exactly what I want to go over with him here.

THE COURT: Well --

MR. HARVEY: What document are you looking at, Mike, just to be clear?

MR. BECHER: The Bethlehem Mine.

MR. HARVEY: Okay. It's not --

THE COURT: I couldn't hear you. What did you say? Which document?

MR. BECHER: The Joint Exhibit 62, the Bethlehem Mine Corporation.

THE COURT: And what is this?

MR. BECHER: This is baseline environmental data that was taken by a mining company in this watershed prior to

mining.

THE COURT: All right. Prior to mining. And you're saying that it wasn't provided to or relied upon by Mr. King in forming his report.

MR. BECHER: It was not mentioned in his report, but he was given this document in deposition and deposed about it.

MR. HARVEY: He was given the document by Mr. Lovett, Your Honor. And I have the section of the transcript right here.

THE COURT: Is that accurate? He didn't have the report prior to the deposition?

MR. BECHER: I believe it was Mr. Harvey that gave him this document.

MR. HARVEY: No, it was not, Your Honor. If it would help, we can put the transcript on the screen.

Not until he asks.

MR. BECHER: If I'm -- if I may, Your Honor, Mr. Lovett has just refreshed my memory and is telling me that even if he's the one that physically handed over this document, we obtained this information from the defendants.

THE COURT: Well, here's my problem: And I'm not questioning the authenticity of the document or those things. The problem is this: If the expert is expected to be providing opinions based upon his review of the document, then it sounds like he didn't have the document until he'd already

formed his opinions until he was being deposed.

MR. HARVEY: Your Honor, would it help if I showed the transcript from deposition?

MR. BECHER: Your Honor, we didn't have this document until deposition. I mean this is a document that the defendants had in their possession that we didn't get until deposition and then had a chance to depose him about it.

MR. HARVEY: I can also --

THE COURT: Well, all right. We're going to get too far afield. Is there another subject or area you could switch to at this point and they we'll come back to this?

MR. BECHER: This is actually my last topic, Your Honor.

THE COURT: All right. Well, so was there anything in the doctor's report where he discussed pre-mining conditions or reports of sampling or testing pre-mining other than the ones you've already gone through that are part of the stipulation?

MR. BECHER: He did not specifically discuss pre-mining data, but he did discuss the conductivity sensitivity of the species that we were able to have from our information that we now know are there and testified about this topic that it is the less tolerant, less sensitive species that we're now finding at Stillhouse Branch.

THE COURT: Well, you've confused me. So you want

to ask him questions about this nature of the species, the characteristics of the species that are found there now.

MR. BECHER: I want to ask -- I want to compare the species there now versus the species that were there in this baseline data.

Mr. -- or, excuse me -- Dr. King clearly notes in his report that he would be talking about this subject, species tolerance, genera tolerance to conductivity, using the available data that we have, current data. And at the deposition, we were provided this document. And the defendants had the opportunity to depose him on this document as well, which contains similar information for pre-mining conditions.

THE COURT: All right. Mr. Harvey?

MR. HARVEY: Mr. Tyree I think can put the transcript up on the screen from the deposition. I can clear this up.

THE COURT: Go ahead.

MR. HARVEY: This is Mr. Lovett's examination of Dr. King after I deposed him.

Question: Mr. Harvey asked if you looked at any pre-mining benthic data at Stillhouse in his questioning. Do you recall that?

Answer: Yes, I did.

I think you said you don't recall any; is that right?

Answer: I did say that.

Do you remember, though, the 1977-78 Bethlemen Steel study that was discussed at the *Muttley* trial?

I think he meant the *Elk Run* trial.

Yeah.

Here, I'm going to hand it to you now and see if that refreshes your recollection and if there are any data that you've seen before about the pre-mining.

Your Honor, this wasn't something we provided them at the deposition. This was something from the *Elk Run* trial they brought and tried to present Dr. King with. It wasn't part of his report in any way.

THE COURT: Well, wait a minute. That just said that you're the one that handed him this exhibit.

MR. HARVEY: That's Mr. Lovett.

THE COURT: Oh, I'm sorry. Go through it again.

MR. HARVEY: Mr. Lovett is saying, "I think you said you don't recall any; is that right?"

THE COURT: Oh, I understand now.

MR. HARVEY: Then Mr. --

THE COURT: So your assessment of this is that the witness acknowledges having seen this but for the purposes of some other case, in another trial.

MR. HARVEY: And Mr. Lovett puts it in front of him and asks him if that refreshes his recollection. There was

nothing that he --

MR. BECHER: Well, we'll just talk about the current data.

THE COURT: Yes. I mean it seems to me if this document was presented to the witness at his deposition, it seems clear that he didn't have it before and he didn't form opinions based upon it, and so I don't think that he can add that at a deposition, especially when it's presented in this fashion, and use that as a basis for testimony at trial. I sustain the objection.

BY MR. BECHER:

Q. Okay. If I could, first let me bring up a figure in your report. Please turn to Joint Exhibit 33. And this was a chart that appeared in your rebuttal report; is that correct?

A. Yes.

Q. Can you tell me about this chart?

A. This is the list of taxa that were found in the Fall of 2013, I believe, by Chris Swan.

Q. And are those the Swan data that Dr. Palmer testified about yesterday?

A. Yes, I believe they are.

Q. And what did you find in reviewing these data?

A. Well, that the taxa that were present represented a list of only highly conductivity-tolerant taxa. So -- and, in fact, several of these on this list are the same ones that we

found when we -- in the "How Many Mountains" paper that were predictable increasers, that is, what we tend to find at high conductivity sites.

So the conductivity thresholds for these taxa, the lowest one is *Leuctra*, which is that stonefly that we tended to only find one of every time at these sites, but we do tend to find it there, and it happens to be a very conductivity-tolerant stonefly and --

Q. How tolerant?

A. Well, it's basically set at greater than 2087. So basically it kind of increases, and, you know, it could be even higher. Its extirpation could be even greater than 2087 is what they're saying, but it's at least 2000.

Q. These are all highly tolerant for conductivity in your opinion?

A. Yeah. Some of them are set at 11,000. So I mean it's -- they're all very highly tolerant.

Q. And let's actually turn back to the Swan family data. I believe that is Joint Exhibit 50. Excuse me. This is the genus-level data that I wanted to go to, but I said family-level data. But it's Joint Exhibit 15, page JE 50.

A. Okay.

Q. Again, this is the list of genera that Chris Swan found at Stillhouse Branch; is that correct? Is that your understanding?

A. Well, it says from Pennington & Associates, but, yeah, I believe that's right. Yes.
Q. Okay. Do you see any mayflies?
A. No.
Q. And I think you'd said previously that that was one of the indicators of high conductivity, the absence of mayflies?
A. Yeah. I mean, again, sites that have low conductivity, less than 200 in the West Virginia database, have mayflies basically a hundred percent of the time, at least one mayfly genera, genus; and there's none, none here.
Q. Can you tell me if any of the species that you see -- excuse me -- any of the genera you see here are of the kind that you or Pond or others found to be sensitive to conductivity?
A. No.
THE COURT: You're looking now at --
MR. BECHER: Still on the same chart, page JE 50.
THE WITNESS: No, I mean these are not -- these are not sensitive taxa. I mean these are the toughest of the bunch.
BY MR. BECHER:
Q. When it comes to conductivity?
A. Exactly.
Q. Do you see any that were on the list of taxa expected to increase or do well in high conductivity waters?

A. Yes, several of these.
Q. Can you point just a few of those out?
A. Yes. *Ceratopsyche*, *Cheumatopsyche*, *Hydropsyche*, *Hydroptila*, *Cricotopus*. I mean, yeah, there's several here that are predictably, you know, good indicators of high conductivity sites.
Q. Okay. So would you say this fits within the pattern established in the literature of species you would find in a stream that's degraded by conductivity?
A. Yes. And I also note that most of these are -- you'd categorize as clingers. That would be taxa that you'd find with good -- a good high-flowing stream, with minimal sedimentation, and lots of interstitial spaces between the rocks for habitat.

Clingers are usually ones that are impacted greatly by habitat degradation related to, for example, sedimentation.

And, again, this leutrid we know from our Maryland work that Matt Baker and I published is remarkably sensitive to urbanization gradients where you have high embeddedness, flashy flow, habitat degradation. It disappears at very low levels of urbanization, and yet it's one of the most tolerant to conductivity.

So it's a good way of -- you know, multiple lines of evidence sort of showing that some of the things here aren't necessarily just tolerant of everything. They're specifically

tolerant to this mixture of ions.

Q. And I don't want to go back through it, but did you also review the chemical data that was taken by Mr. Evan Hansen and the physical habitat assessment that was done by Dr. Chris Swan --

A. Yes.

Q. -- in forming your opinions here?

A. Yes.

Q. Based on your review of this data and all of those data, do you have any doubt that it is conductivity that's causing the impairment in the stream?

A. I mean the bottom line is conductivities at this level will unequivocally impair a stream. So the habitat that was measured at this site scored a 130, which is in the suboptimal, but, you know, it's a fairly average value for streams. It's not considered bad.

All the other data that was measured, you know, dissolved oxygen, things of that nature, were well within range. And, again, the temperature data at this site suggests it gets up to 23, 24 degrees C. That is in no -- no way result in this level of impairment. It just simply would not.

And I mean I think the graph that I showed earlier showing streams with, you know, 28 degrees and, you know, 10 mayfly taxa alone completely blows that argument out of the water. I mean it just -- that alone just completely

demonstrates that temperature is not confounding this.

MR. BECHER: Thank you. If I may have a moment, Your Honor.

THE COURT: You may.

BY MR. BECHER:

Q. Is there anything else that you'd like to explain to the Court to sort of clarify about your opinion?

A. I mean I guess my opinion is based on just multiple lines of evidence ranging from what's become a very large body of literature, my own data analysis, my own review of the data at this site, looking at the specific list of taxa that are present at this site, my awareness of the taxa that were there before.

Collectively I believe there is a consensus in the scientific community not only of general causation that conductivity is, in fact, the principal cause of biological degradation below alkaline mine drainage -- with alkaline mine drainage, and in this particular site there's specific causation that is, to me, unequivocally the principal cause is conductivity associated with the mine, and that if you were to reduce the conductivity to a level of, say, 200, that you would see a dramatic increase in the number of sensitive taxa.

You know, it might require restoration efforts in terms of bringing taxa to actually see that area, but I think you would see increases and potentially the site would no longer

be impaired.

However, if you were to, for example, lower the temperature by two or three degrees consistently, my opinion is that it would have absolutely no effect on this stream. It would not restore the stream. It would still be biologically impaired. I'm absolutely convinced that is the case.

Q. Do you hold the opinions you've expressed today to a reasonable degree of scientific certainty?

A. Yes.

MR. BECHER: Nothing further.

THE COURT: All right. We'll go ahead and take an early lunch break at this time. It's 11:30. Let's take a break until 12:30.

You may step down. Don't discuss your testimony with anyone.

We'll stand in recess until 12:30.

(Lunch recess from 11:30 a.m. to 12:35 p.m.)

AFTERNOON SESSION

THE COURT: All right. Are we ready?

MR. HARVEY: Yes, Your Honor.

THE COURT: All right. Dr. King, if you'll resume the stand.

MR. MCLUSKY: Your Honor, I think that the agreement is Dr. Palmer cannot be present during this.

THE COURT: That's my understanding. The parties

agreed that experts would not be present during the cross-examination of their fellow experts.

All right. Mr. Harvey, go ahead.

CROSS EXAMINATION

BY MR. HARVEY:

Q. Good afternoon, Dr. King.

A. Hello.

Q. We discussed at your deposition the West Virginia Stream Condition Index is based on conditions in West Virginia reference streams, correct?

A. Correct.

Q. And I think you told me that WVSCI scores essentially measured departures from those reference stream conditions, correct?

A. WVSCI scores measure the biological condition of the stream, and the scoring of it is relative to a set of sites that were considered to be reference sites, yes.

Q. Okay. And you did not conduct a site visit in this case, correct?

A. No, I didn't conduct a site visit, but --

Q. Dr. King, I just want to know, yes or no, did you conduct a site visit?

A. No, I didn't.

Q. Okay. But you have seen photographs of the site, correct?

A. I have.
Q. And do you recall our discussion of the ways in which Stillhouse is different from a West Virginia reference stream?
A. I recall our discussion about that, yes.
Q. You told me that one of the differences is that Stillhouse has a valley fill, whereas a reference stream did not, correct?
A. That is true.
Q. And Stillhouse has sediment ponds, correct?
A. Stillhouse has sediment ponds, that's correct.
Q. And unlike a reference stream, Stillhouse has a steep concrete flume, correct?
A. Yes. That's part of the site, yes.
Q. And further downstream there are culverts which you would not typically find in a reference stream, correct?
A. Not typically, no.
Q. Okay. Streams are often impaired even where conductivity scores are low, correct?
A. Sure, that can happen.
Q. I'd like to show you a graph prepared by the West Virginia Department of Environmental Protection. It's part of Joint Exhibit 60, which you and Mr. Becher discussed earlier. It could be found on page 699 under tab JE 60.
Mr. Tyree is going to put that on the screen as well.
A. Yes, I believe we've looked at this one before.

Q. And you would agree with me that there are numerous sites below a conductivity level of 300 that are also having WVSCI scores below 68.
A. Yes, there are.
Q. Okay. And do you recall our conversation at your deposition about things other than conductivity that can lead to stream impairment?
A. Generally, I do.
Q. Okay. For instance, you told me in-stream habitat conditions can cause WVSCI scores to decline, correct?
A. Yes, that is correct.
Q. And you told me that flow alterations can lead to failing WVSCI scores; is that correct?
A. Yes, although I don't know if we put this much data to that effect.
Q. But you told me they can, correct?
A. Yeah. If there's no flow in the stream, it can lead to a failing WVSCI score, yes.
Q. And you told me that the availability of food sources can cause WVSCI scores to decline, correct?
A. I mean, yeah. If there was essentially no leaf litter or periphyton growing on rocks, that could lead to that, but that's not the case at Stillhouse.
Q. I didn't ask you that. I asked you did you not tell me that differences in flow -- I'm sorry -- in food availability

can cause WVSCI scores to decline.
A. I mean, I answered.
Q. Yes, correct?
A. Yeah. If that were the case, it could cause that.
Q. Okay. And you told me -- and I want to get your quote exact here -- that, quote, completely burying part of the upstream area could have some influence on the stream below, closed quote. Do you recall telling me that?
A. Vaguely, and I said it could have some influence, yes.
Q. We also discussed drifting organisms at your deposition. Do you remember that?
A. I do.
Q. What are drifting organisms?
A. Well, stream organisms will drift when their populations reach a size where there's -- particularly when there's a recruiting group of the same mayflies. They'll initially get hatched where there's potentially thousands of small ones; and as they grow, there's not enough food necessarily, and so many of them will drift downstream to a different patch.

It could be drifting from one rock to the next or drifting for, you know, until they essentially find a patch where there's suitable habitat and food resources. They also drift to avoid predators.

Q. Okay. And do you recall our discussion in your deposition of the effects that a sediment pond and concrete

flume --

THE REPORTER: I'm sorry. Can you talk louder --

MR. HARVEY: Yes.

THE REPORTER: -- or get closer?

BY MR. HARVEY:

Q. And do you recall our discussion at your deposition of the effects that a sediment pond and concrete flume may have on the number of drifting organisms at a site?

A. Again, I vaguely remember we discussed it, but, yeah. Yes.

Q. Do you recall telling me that you do not know whether the pond and flume would reduce the abundance of drifting organisms at this site?

A. I think that's correct. I don't necessarily know -- I don't necessarily think that there's strong evidence that it would.

Q. But you do not know.

A. My opinion is, is that it probably would not, but I don't know.

Q. Mayflies, correct? Is that correct?

A. It can, yes.

Q. Okay. Have you performed any studies examining the effect of flow alterations at this site?

A. Have I performed studies on flow alteration at this site? I'm not aware of any studies on flow alteration at this site.

Q. So Dr. Palmer didn't perform any either?
A. I mean she performed -- when you say studies, I mean she performed an assessment of it, sure.
Q. Did she gather any data?
A. Yes.
Q. What data did she gather about flow?
A. Well, she measured velocity. She measured dissolved oxygen in the stream. She measured, you know, discharge; yeah, and so there were data gathered on it, sure.
Q. Did she do any analyses comparing that to reference sites?
A. You know, my understanding is that it was within the range that you typically would see at a reference site, sure.
Q. Did she do any analyses?
A. I don't think she did any analyses, but I'm aware that --
Q. Please, pay attention to my question, and I'll try to make this as civil as possible.

Have you performed any studies examining whether the food sources are adequate at this site?
A. I have reviewed the data that Dr. Palmer collected and her personal opinions about food sources at the site, and my opinion is, is that the food sources were present and adequate.
Q. Did you perform any studies?
A. I did not, no.

Q. Thank you. Did you perform any habitat studies beyond looking at what Dr. Swan had calculated in the way of RBP scores?

A. I examined the existing data with respect to habitat at this site in question, yes, but I didn't personally measure -- go out and measure the habitat at the site, no.

Q. I think you told me that RBP scores are performed in a 100-meter reach of stream; is that correct?

A. It varies, depending on the -- 75 meters, 100 meters. It depends on the site. There's exceptions, depending on availability of, you know, landowners, things of that nature. But typically 75 meters, 100 meters, something like that.

Q. Okay. And Dr. Swan performed his RBP analysis downstream of the concrete flume we've discussed, correct?

A. That's my understanding.

Q. And do you recall telling me at your deposition that RBP scores will not necessarily tell you everything about the stream reaching up to the headwaters above?

A. I mean, that's -- yeah, that's true. I mean it wouldn't necessarily tell you everything about the stream.

Q. And do you recall telling me that you do not know whether RBP scores will reflect changes in food sources for bugs?

A. I did say that I can't be certain, but if you have an RBP score that is in the optimal/suboptimal range, it's usually indicative of conditions that are favorable for food

resources. So, again, I don't know, but my opinion is, is that food sources will probably be adequate.

Q. But you don't know.

A. I can't be certain.

Q. I'd like to discuss table B-19 with you, Dr. King. It's a table that I believe you and Mr. Becher discussed. It's in Joint Exhibit 58 and can be found on page JE 492.

We talked about this table -- tell me when you get to it, Dr. King. I'm sorry.

A. Okay. I'm there.

Q. And we talked about this table at your deposition. Do you recall that?

A. I think so, yes.

Q. And this table shows where the mayflies are present at certain temperature and conductivity levels, correct?

A. Yes, that's correct.

Q. It doesn't tell us whether WVSCI scores are passing at these temperature and conductivity levels, does it?

A. I mean it's specifically about mayflies, which are the sensitive group and which tend to drive WVSCI scores, as your expert has said in the past.

Q. It doesn't tell us whether the WVSCI scores are passing or failing, does it?

A. No, but it's a component metric of the WVSCI.

Q. And I think you told me at your deposition that at 200

conductivity, there could be a mayfly present, but the WVSCI scores could be failing, correct?

A. Yeah, that's possible.

Q. And at your deposition, you told me that you did not know whether the habitats are the same for the 200 conductivity bins as the 1500 conductivity bins; is that correct?

A. Well, yes. If you take this table in isolation of all the other contingency tables, that would be true, but there's several other contingency tables where they examined that. So --

Q. I understand, but in this table, you did not know whether the habitat is the same in the 200 --

THE REPORTER: I'm sorry. Is your microphone on?

MR. HARVEY: I'm leaning back. I've got a bad back. I'm sorry. I'll try to stand closer to the mic. I apologize.

THE WITNESS: Well, again, to fully answer your question, it's important to recognize that as part of both the causal analysis and confounding analysis, they examined whether or not habitat was a confounding factor and was it correlated strongly with conductivity, and it was ruled out as the correlate. And so I can assume that the habitats on both of those sides are not markedly different.

BY MR. HARVEY:

Q. Do you know?

A. I'm fairly confident that they're not markedly different.

Q. Do you recall your deposition in June of this year?
A. I mean, like I said, I'm not a hundred percent certain, but I'm confident that they're not markedly different because I've reviewed -- I mean, is it unreasonable for me to have reviewed things since my deposition?
Q. Do you recall your deposition?
A. I recall my deposition.
Q. And you took an oath at that deposition to tell the truth, correct?
A. Yes, I did.
Q. I'm not suggesting that you did not, but -- Mr. Tyree, can you put up page 111 of Dr. King's deposition.
Question -- Dr. King, it's on the screen to your left. On page 111 of your deposition was, "Do you know if the habitats were the same between these two groupings?" And your answer was, "I don't."
A. And then I finished the sentence by saying, "But they've done a comparable analysis," and I elaborated, basically saying the exact same thing I just said.
Q. I understand, but I just want to make it clear that you do not know if the habitat conditions were the same.
A. Okay. If we're going to say "the same" means identical, you're right, I do not know.
Q. This table was compiled from snapshot temperature data; is that correct? Can you put the table back on the screen,

Mr. Tyree? Thank you.

A. The table was compiled from the West Virginia database which -- in which all of the data regarding water chemistry and habitat is a snapshot; it's a single site visit. So, yes.

Q. And then in the *Elk Run* trial last December, you testified that snapshot temperature data is almost useless. Do you recall that?

A. I recall saying that in the specific context of referring to Dr. Menzie's use of a single measurement at a reference site and a single measurement at the mine site. He was using that as a means to compare. And it was obvious that the measurements were taken on different days and different air temperatures.

And so in that context, I said snapshot data comparing two sites like that is almost useless. So context is very important.

MR. HARVEY: Mr. Tyree, can you pull up Dr. King's testimony in the *Elk Run* case? Page 238.

Your Honor, can I approach?

THE COURT: You may.

BY MR. HARVEY:

Q. Dr. King, the question in the *Elk Run* case was from Mr. Lovett. And read with me here, if you would.

The question is, "Okay. What does that tell you, if anything, or does it tell you anything?"

"Well, it doesn't tell me anything. For one thing, none of these temperatures are sufficient to cause biological impairment like we've seen at these sites. I also have no idea when they were collected. A snapshot measurement of stream temperature is almost -- almost useless."

Is that your testimony at the time?

A. It was; and, again --

Q. Dr. King, I'm just asking you if that was your testimony at the time.

A. It was, in the context of comparing the two measurements that Dr. Menzie had taken on different days, at different times, just comparing those two sites. So that was the context.

Q. Do you recall telling me in this deposition in this case that stream temperature can go from 10 degrees in the morning to 25 degrees in the afternoon?

A. Yes, it can.

Q. And do you recall telling me in this case, not talking about Dr. Menzie, that snapshot temperatures can't be very representative of the long-term condition of a stream?

A. I did say that, and I think one of the things to keep in mind --

Q. Dr. King, I don't mean to cut you off, but I just want to --

THE COURT: Just answer his question.

THE WITNESS: Okay.

THE COURT: Go ahead.

BY MR. HARVEY:

Q. Dr. King, these temperature measurements that we see in table B-19 might have been taken in the morning but reached higher levels in the afternoon, correct?

A. Well, there's thousands of collections, and so they're almost certainly all taken -- in fact, they're taken across seasons and across different times of the day. So essentially what we have is a large number --

Q. Dr. King, I'm sorry. It was a simple question. The temperatures shown in this table may have been taken in the morning and had reached higher temperature levels in the afternoon, correct?

A. There is almost certainly an equal number of observations from morning, midday, afternoon, and the evening because that's the way the biological surveys work. So, no, that's not correct.

I mean it's correct that the temperatures can change during the day, but what you're implying is that some of the temperatures were all taken in the morning, which is incorrect.

Q. I didn't say that. I said is it possible that some of these temperatures may have been taken in the morning --

A. It's not only possible, it's a fact that some of them

were taken in the morning and some were taken in the afternoon.

Q. Because they're snapshot temperature.

A. Because they visit the site, they collect the data, and they measure the temperature. But because of that, then we have a large number of sites and we have a large number of temperatures. So, for example, if you have a high temperature --

Q. Dr. King, please. The question was, were some taken in the morning possibly higher in the afternoon. The answer was yes, correct?

A. Okay.

Q. And some of these measurements may have been taken in the spring but have reached higher levels in the summer, correct?

A. Correct.

Q. And you believe this table is fairly inconclusive, right?

A. That this table is fairly inconclusive?

Q. Yes.

A. No, I don't.

MR. HARVEY: Mr. Tyree, can you pull up page 124 and 125 of Dr. King's deposition testimony.

BY MR. HARVEY:

Q. Dr. King, I'm going to read to you -- and it's on the screen to your left if you want to follow along -- part of your deposition testimony.

I asked you the following questions:

Now, we know it's cooler when that measurement was taken. We don't know anything else about the site throughout the year, correct?

Answer: Presumably that's true. I mean it is a snapshot, you know. A warm temperature probably tells us more because it's pretty warm. It could get warmer, but, you know, it could -- but the fact that it's warm could tell us that it's hitting a thermal maximum. Again, in this particular case, we see high conductivities. In the warmer temperatures, we actually see more mayflies than we do with the lower temperatures.

Question: Right. But, again, we have no knowledge.

Answer: Yeah, I would say in comparing these two bins, it probably is fairly inconclusive.

Is that your testimony?

A. It is my testimony. I'm not sure what --

Q. Dr. King, is that your testimony?

A. That was my testimony, but I'm not sure what I'm responding to in --

Q. I read you the questions, Dr. King.

A. Yeah.

Q. Now, the cause of the limitations in EPA's table here, you used a different method than EPA to eliminate temperature as a confounder; is that correct?

A. I addressed temperature as a confounder in a different way, yes.

Q. Because EPA's analysis was not complete, correct?

A. No, it was -- I looked at it in a different way, so not because it was incomplete.

Q. Mr. Tyree, can you go to page 130 of Dr. King's deposition?

And we're talking about this table, I'll represent to you, Dr. King. And it's to your left on the screen if you want to review it.

And the questions and answers are as follows:

Question by me: Do you stand by your earlier conclusion that the snapshot data of temperature is almost useless?

Answer: Well, it's almost. It has some use.

Question: Okay.

Answer: If you don't have it, it's better than not having any.

Question: Okay. If you were helping EPA and trying to eliminate temperature as a confounder, is this what you would do, or would you do something different?

Answer: Using the existing data? I think I would do what I did, which was look at the relationship between temperature and conductivity, temperature and mining, temperature and WVSCI, temperature and mayflies, and that alone to me was enough to show that temperature wasn't a

confounding factor. This -- this little matrix is interesting, but I just -- I think just examining the relationship among these variables is an even more direct way from a statistical perspective because it -- I think you meant to say "does not" confound that relationship. It cannot be the hidden variable that really is explaining the pattern if it's not related to the other variables.

Is that your testimony at the time?

A. Yes.

Q. So you looked at the relationships between various variables, and you and Mr. Becher discussed those during your direct examination, correct?

A. That's correct.

Q. For instance, you looked at the relationship between conductivity and temperature, correct?

A. I did, yes.

Q. And I'm going to show you that graph that you and Mr. Becher discussed. It's Joint Exhibit 29. If you want to look at the one in your notebook, I'll give you time to look at that.

A. Yes.

Q. Do you have it, Dr. King?

A. I do.

Q. Okay. And this graph is based on snapshot data, correct?

A. It is.

Q. And based on the low R-squared number in this graph, you concluded that temperature and conductivity were weakly correlated; is that right?

A. Yeah, I mean and by visualizing the data as well, the pattern shows that there's a weak correlation; and, in fact, as conductivity, you know, increases, temperature is essentially very -- very flat. So there's not -- there's not a relationship here that would be confounding. And EPA actually did do a correlation analysis with the confounding factors. So they did --

Q. We're going to talk about that. So that will be next.

You say it was flat. You conducted this analysis only on summer data, correct?

A. Well, and for good reason, yes.

Q. Is that correct?

A. It is correct.

Q. Okay. And in the summer, the data flattens out, doesn't it? You said that earlier to Mr. Becher.

A. The summer, the data is -- yeah, in summer we have a pattern where generally the -- the pattern from June, July to August among streams is -- at least the range of temperatures is similar.

Now, there's some early June samples, there's a trend -- in retrospectively analyzing the data, there's a trend where early June tends to be a little cooler. And so I probably

should've restricted this analysis truly to summer, which would be June 21st through the end of August.

Q. And as you said before, that flat data will give you a lower R-squared number, correct?

A. No. I'm referring to a trend across time in the summer.

Q. Okay.

A. So not that -- the relatively low change in temperature across that time span would allow us -- well, if you have a temperature that's changing, for example, in the spring, like Dr. Menzie included all that data across all that time, that analysis is confounded by seasonable variation in temperature because you have a mix of some of the low temperatures are going to be low because it's spring.

The purpose of binning the data in the summer was to eliminate the changing temperature in the spring. So these temperatures should at least represent more approximately, you know, a constant, you know, across sites over time, so without seeing a seasonable change as much.

Q. You have an R-squared number of .05, correct?

A. Yes.

Q. And as you said, EPA also did a correlation between temperature and conductivity; is that right?

A. Yes, and --

Q. That wasn't mentioned in your expert report, was it?

A. I don't think it was, but it's in the benchmark. I

mentioned the benchmark pretty thoroughly, so --

Q. Did you realize that EPA did a correlation after your deposition?

A. I realized through the confounding factoring also said that they had done that, yes.

Q. Did they do a correlation on the entire West Virginia dataset, not just summer? Correct?

A. That's true. That's true.

Q. And they come up with a number that's very different than yours; isn't that correct?

A. Can we --

Q. Sure.

A. -- look at the --

Q. Let's look at figure 13e from the benchmark. But in the notebooks, I believe that will be Joint Exhibit 58, Your Honor, page 414.

Have you seen that table before, Dr. King?

A. This scatterplot matrix?

Q. Yes.

A. I have. These I'm not sure --

Q. I just asked you had you seen it.

A. So, yeah. I have, yes. And you said the values were different, but that's a correlation coefficient. So it's .4. So the square of it would be -- the variance explained would be 16 percent.

Q. Okay.
A. So it would be R-square .16. So --
MR. HARVEY: Okay. May I approach, Your Honor?
THE COURT: You may.
BY MR. HARVEY:
Q. And just so everybody understands how to read this table, Dr. King, confirm what I am saying is correct.
If you're looking for correlations in matrix, say, between temperature and conductivity, you would go straight up from the joinder of those two, and this shows a correlation between conductivity and temperature; is that correct?
A. Yes, that's right.
Q. And it's .4?
A. Yes.
Q. And this graph I'm pointing to, which is the second graph of data down on the left-most column, is the graph of the relationship between conductivity and temperature. Do you see that?
A. I do.
Q. Okay. Is that a weak correlation, Dr. King, .4?
A. That's pretty weak. I mean, again, it's not -- it's certainly not strong. Actually, the number in their table B-20 that they -- they said temperature was moderately correlated with conductivity year-round in the West Virginia dataset May --

THE REPORTER: I'm sorry. You're going too fast.

THE WITNESS: Okay. And they report a correlation of .39.

BY MR. HARVEY:

Q. Okay. Let's talk about how they get there. And that's -- their weighting system is found in appendix B, correct? Do you recall that?

A. Exactly. So JE 493 would be the page.

Q. Actually, I want to take you to JE page 476 in Joint Exhibit 58.

Have you found that page, Dr. King?

A. Yes.

Q. And do you see table B-2 in that page?

A. I do.

MR. HARVEY: May I approach again, Your Honor?

THE COURT: You may.

BY MR. HARVEY:

Q. Dr. King, table B-2 in EPA's benchmark takes different correlations and assigns them various strengths. Do you see that?

A. Yes.

Q. And a correlation between .25 and .75 is described as moderate. Do you see that?

A. That's right.

Q. Okay. And it's given a plus score. Do you see that?

A. Yes.
Q. What does that mean?
A. That means that there's moderate evidence that that -- for that particular relationship could be a confounder.
Q. Moderate evidence of confounding, correct?
A. Yes. But they also found in the EPA dataset the correlation was .17. The EPA dataset was part of it. So they scored that as zero because one of them was weak and one of them was moderate.
Q. I didn't ask you about the EPA dataset. But since you added that, how many sites were in the EPA dataset?
A. I don't remember.
Q. It's in the table you were looking at just now, table B-20, I think.
A. B-20 did you say?
Q. B-20, I believe.
A. Yeah. There were 46.
Q. Forty-six observations. And how many in the entire dataset that we're talking about?
A. 2,216.
Q. Okay. Thank you. Dr. King, you also looked at the relationship between mayflies and temperature, correct?
A. I did.
Q. And you produced a graph that you and Mr. Becher discussed earlier; is that correct?

A. Yes, I did.
Q. Mr. Tyree, can you pull up Joint Exhibit 32 and put that on the screen?
There were some problems with this graph, right, Dr. King?
A. The axis labels were incorrect, yes.
Q. Okay. And I think you said something about it not being a valid statistical relationship; is that correct?
A. Well, the relationship is very weak, yeah. So it's just a trend line.
Q. Okay. This is snapshot data, correct?
A. It is, yes, and so we have a wide range of temperatures.
Q. Okay. And you ran a linear regression on this data; is that correct?
A. It's really just a trend line, yeah. I mean I don't provide any other diagnostic statistics with it, yes. It's a scatterplot.
Q. That's a linear regression on a scatterplot, correct?
A. Sure.
Q. Okay. And this is count data, correct?
A. It is count data, correct.
Q. Okay. It counts number of mayflies, one, two, three, four, correct?
A. Number of mayfly taxa, yes.
Q. Okay. Is it appropriate to run a linear regression on

count data?

A. It depends on the distribution of the residuals from the regression. There's some instances when it can be all right. Otherwise, you use a regression with a different underlying distribution.

Q. What kind of regression?

A. Well, it varies. For example, you can use generalized additive model which has different assumptions about the residuals. You can use a negative binomial regression which is -- still can be a linear regression, but all you're doing is using a different distribution to assess the significance of the relationship. And that's why what I'm telling you here is I'm not presenting any sort of p-values related to this analysis. This is simply a scatterplot with a trend line.

Q. Do you know what a Poisson regression is?

A. I do.

Q. What is that?

A. Poisson is also for count data, but it actually tends not to perform as well as the negative binomial. Most count data in ecological studies are distributed with a negative binomial. So usually we don't use Poisson.

Q. I'm not sure if you agree with me on this or not. Was it inappropriate to run a linear regression on this count data?

A. It's not inappropriate if the distribution of the residuals meets the assumptions of the analysis. The point

here, this is --

Q. Well, let me ask you, do they?

A. The residuals in this case are probably not normally distributed, no; and, in fact, the relationship, regardless of the technique -- and, again, I did not present p-values or other diagnostic statistics with this. It is simply a trend line.

And what it shows is -- you can look at the data; you can look at the scatterplot. The relationship is virtually non-existent. And the point of the graph is that there are very high values for numbers of mayflies at all temperatures observed in the dataset. There are temperatures that are up to 28 degrees with 10 mayfly taxa occurring there, okay?

So snapshot data or not, if you have a temperature of 28 degrees, you have a temperature of 28 degrees. And if there are that many mayflies there, it strongly refutes the idea that temperature is a confounding factor with respect to conductivity.

Q. The point of this graph was that the R-squared number was low, wasn't it?

A. No.

Q. Isn't that what you said in your deposition?

A. Look -- why would I put a box around the upper part of the data and annotate it if the point of the graph was the regression?

The point of the graph was to show, visualize, that there is essentially no pattern with respect to temperature and that indeed you find mayflies, large numbers of them, different genera, at all temperatures during the summer, even though it's a snapshot.

Q. You were trying to show there was a low correlation between mayflies and temperature, correct?

A. I was showing not just that there was a low correlation; I was emphasizing the values of numbers of mayflies that occur at high temperatures.

MR. HARVEY: Mr. Tyree, can you pull up Dr. King's expert rebuttal report? It's not paginated, Mr. Tyree, but can you go over to the second page of that report?

May I approach, Your Honor?

THE COURT: You may.

BY MR. HARVEY:

Q. Dr. King, I'm going to read to you from your expert rebuttal report.

Does this look like your expert rebuttal report?

A. It looks like it.

Q. Okay. Paragraph two, "In determining whether a variable confounds a causal relationship, one issue is whether the variables are closely correlated. If they are not, we can use statistical analyses to look at the way the variables influence the observed outcome. I have used statistical

analyses to support the conclusions by EPA that temperature does not confound the effects of conductivity. I also demonstrate, through statistical techniques, that Menzie's criticisms of EPA for using individual temperature measurements rather than measurements over time is not well-founded."

Here's the important part. "First, I have run analyses confirming that temperature is not well-correlated to conductivity or to the extent of mining in a watershed. This is likely true even if we use only data from summer months when maximum temperatures are likely to occur and lack of canopy is likely to have the most profound effects."

Mr. Tyree, can you scroll down?

There's a series of graphs here, and then you've got a sentence that says, "Further, the conductivity is much more strongly correlated with numbers of mayflies, the key driver of biological impairment, than high temperatures."

Do you see that?

A. Yeah.

Q. And then we've got a graph, correct?

A. Sure. And would you scroll down and read the rest of it?

Then I drive home the point that the distribution of numbers of mayflies across the temperatures that were observed in these dataset demonstrate that it is virtually impossible for temperature to be confounding the effect of conductivity

on biological conditions if, in fact, we have numbers of mayflies that are essentially unaffected across the full range of temperatures, and the mayflies being the most sensitive group to conductivity.

I mean this graph refutes conclusively, regardless of the linear regression and the assumptions. I mean you could run any statistical method on this regardless and come to the same conclusion. This relationship is extraordinarily weak, and there is an obvious pattern that higher temperatures have no effect on the ability to get large numbers of mayflies.

Q. Dr. King, let's try this in a different way. In the *Elk Run* trial, do you recall telling Mr. Lovett that the correlation between smoking and lung cancer was very low?

A. Vaguely.

Q. Mr. Tyree, can you pull that up so we can show that to Dr. King? It's from the *Elk Run* transcript, page 316.

May I approach, Your Honor?

THE COURT: Yes, you may.

BY MR. HARVEY:

Q. Dr. King, this is a question from Mr. Lovett in the last trial. The question was as follows:

"So how much variance, if you know, is typically explained in statistical models for things like smoking and lung cancer, for instance?"

And would you read your answer for me, please?

A. Sure.

"Well, so, for example, there's studies that -- like numbers based on how many cigarettes somebody smokes and the probability of getting lung cancer, and I think the variance is -- explained is only like some 8 percent, 12 percent, 15 percent. But obviously we all agree that's a -- that's a very, you know, very -- it's highly significant and it's predictive, but the variance of your" -- some of this doesn't read well.

Q. We run on all the time too. You can skip the word "like."

A. "You're probably -- there's so many other factors that contribute to whether an individual gets cancer or not."

Q. Now, Dr. King, if you were studying whether asbestos, for instance, caused lung cancer, would you rule out smoking as a potential confounder because it has that low correlation?

A. I think we're talking about something that's very different. I think the issue, the question, is whether or not the relationship of conductivity is confounded by temperature, okay?

And the relationship of conductivity is not confounded by temperature. It doesn't necessarily mean that temperature has no effect. It might. But it's not a confounder. It's not altering the relationship. It's not driving the relationship.

Q. Dr. King, I'd like you to answer my question. If you

were studying whether asbestos caused lung cancer, would you rule out smoking as a potential confounder based on the low correlation between smoking and lung cancer?

A. In that instance, no, I wouldn't.

Q. Because smoking is a risk factor for lung cancer, correct?

A. That's correct.

Q. Dr. King, this is the *Reference Manual on Scientific Evidence*. It's something that judges use to educate themselves on scientific topics.

Would you agree with me that's probably a reliable source for scientific information?

A. I would suppose so. I don't know.

Q. I'd like to take you to page 591 of that book. Mr. Tyree is going to put it on the screen.

May I approach, Your Honor?

THE COURT: Yes, you may.

BY MR. HARVEY:

Q. This is a section under the epidemiology chapter, Dr. King, with the title Could a Confounding Factor Be Responsible for the Study Results.

Do you see that?

A. Yes, I see that.

Q. And there's a sentence here one, two, three, four, five lines down that says, quote, "One instance of a confounding --

one instance of confounding is when a confounder is both a risk factor for the disease and a factor associated with the exposure of interest."

Do you see that?

A. I do.

Q. Okay. Do you disagree with that?

A. Do I disagree with that sentence? No.

Q. Okay. Do you believe it is good practice to use correlation coefficients to identify a confounding?

A. I think it's one -- one method of several to evaluate confounding.

Q. I understand it's one method. Is it a good practice is the question.

A. It's a standard practice.

Q. In what field?

A. A standard practice I believe in epidemiology, in eco-epidemiology, ecology, medical science, several fields.

Q. Okay. I'd like to show you an article published in the *American Journal of Epidemiology*.

Mr. Tyree, can you pull that up?

Dr. King, have you -- go back to the top, Mr. Tyree.

Dr. King, the title of this article is The Fallacy of Employing Standardized Regression Coefficients and Correlations as Measures of Effect.

Do you see that?

A. Sure.
Q. Have you heard of the *American Journal of Epidemiology*?
A. I've heard of it.
Q. You'll see, if you look to your left, the journal was published by Johns Hopkins University. I assume you've heard of Johns Hopkins University.
A. I have, a very good university.
Q. Do you believe that Johns Hopkins University is a reliable source of information?
A. Yes, I do.
Q. Mr. Tyree, can you go to page 206 of this article?
Would you mind reading the paragraph that starts with the word "Blalock."
A. "Blalock notes yet another problem with the use of partial correlations as measures of effect. The magnitude of such correlations can in general be expected to change upon control of additional variables, even if these additional variables lack one of the two associations necessary to be a confounder. That is, association with the exposure variable and association with the outcome variable."
Continue reading?
Q. Yes, please.
A. "This occurs because control of an additional variable, even a non-cofounder, will reduce the residual variance of any correlated variable, and residual variances are key elements

in determining the partial correlation. Thus, evaluation of confounding using correlation or path coefficients can be particularly misleading."

Q. Dr. King, you don't hold yourself out as an expert in statistics, correct?

A. Not in all areas of statistics, no.

Q. Which areas are you not an expert in?

A. I'm an expert in areas that deal with ecological and environmental statistics and data analysis.

Q. Which areas are you not an expert in?

A. Well, that would be I'm not an expert in areas that fall outside of that.

Q. I think you told me at your deposition you've had four classes in statistics; is that correct?

A. I think I've had more than that, but -- I don't think I said four, did I?

Q. I believe you did. Actually, you said five. There was one you didn't count. So I thought of it as just four. As we went through your deposition, which we can review if you want, but I believe you told me five.

A. Okay.

Q. But you told me you do keep statistics textbooks on your shelf.

A. Yes.

Q. Okay. And you told me you developed a software program

to analyze ecological data, correct?
A. Yeah, co-authored with a colleague, Matt Baker.
Q. That is the one you and Mr. Becher discussed called TITAN?
A. That's correct.
Q. TITAN was publicly criticized in a peer-reviewed paper by a professor at Duke named Song Qian; is that correct?
A. He's a professor at the University of Toledo, assistant professor.
Q. He was a professor at Duke at the time he criticized you; is that correct?
A. No. He was a soft money researcher, not a professor.
Q. What was his specialty?
A. He has a degree in environmental science from -- in the same program in which I received my degree.
Q. I thought you told me at your deposition that he was a specialist in Bayesian statistics.
A. Well --
THE REPORTER: I'm sorry. A specialist --
MR. HARVEY: Bayesian.
THE WITNESS: He --
MR. HARVEY: Dr. King, we're talking over each other. B-a-y-e-s-i-a-n. Bayesian.
THE WITNESS: Yes. He applies Bayesian statistics and methods primarily for water quality modeling is what his

training is.

BY MR. HARVEY:

Q. You have no training in epidemiology, correct?

A. That's true. I've never taken a course in epidemiology.

Q. The benchmark was reviewed by a panel established by the Scientific Advisory Board, correct?

A. That's correct.

Q. Science Advisory Board. My mistake.

Do you know were there any experts in statistics or epidemiology who reviewed the benchmark?

A. Well, I'd have to look at the list of names again. May I do that?

Q. Sure. Mr. Tyree just happens to have those.

If it would be easier, Dr. King, this is in Plaintiffs' Exhibit 25, page 374.

A. So Dr. Will Clements is an ecotoxicologist who does have expertise in epidemiology and statistics.

Q. Dr. Will Clements. What do you mean by "he has expertise"?

A. He's published a book called *Ecotoxicology* with some statistical methods in that textbook. He's the author of the text. So I consider that expertise.

Q. I'm asking you if anyone was an expert in statistics or in --

A. He's an expert in statistical methods that apply to the

type of data in the benchmark, yes.
Q. Who else?
MR. BECHER: Can I just ask that the witness be allowed to look at the plaintiffs' exhibit that's written in the notebook?
THE COURT: He can look at the list. It's plaintiffs' exhibit in the notebook?
MR. HARVEY: It's Plaintiffs' Exhibit 25, page 374.
THE WITNESS: Tom La Point also -- an ecotoxicologist at the University of North Texas -- has very strong expertise in statistics that relate to stressor response and toxicology.
BY MR. HARVEY:
Q. What about epidemiology? Is he an expert in epidemiology?
A. I mean his field is very closely aligned to it, yes. So I wouldn't -- he would have to tell you whether he would consider himself an expert in epidemiology.
Q. Okay. Who else?
A. Almost all of these people have a very -- have a very distinguished record in ecology and environmental science which they employ --
Q. Well, I don't doubt that, Dr. King.
A. So --
Q. My question --

A. There's something that needs to be clarified. May I continue?

THE COURT: No. Let him ask his question.

BY MR. HARVEY:

Q. My question is, is there anyone else other than the two persons you named who you believe to be an expert in statistics or epidemiology?

A. In looking at most of these names, what I was going to say is that most of these people have significant expertise in statistics because in ecology, environmental science, that is an implicit part of your training. Ecology may be one of the most statistically-oriented fields in which we as ecologists or environmental scientists are trained to employ our own statistics.

So I would say that there are many people on this list that would be experts in statistical methods that are appropriate for the type of data that occurs in the benchmark document.

Q. Do they have backgrounds like yourself?

A. I'm sure several of them do, yes.

Q. And you don't hold yourself out as an expert in statistics.

A. I hold myself as an expert in the type of statistics and data analysis that apply to this type of data in this benchmark. So I think that is -- that's the point.

Q. Do you know whether the review panel criticized the draft benchmark for failing to use proper statistical techniques?
A. I believe that there were maybe -- it doesn't specify who, because someone -- someone, at least one person, suggested there should have been more use of multivariate statistical approaches.
Q. Right.
A. And -- but --
Q. Dr. King, let's look at that, okay?
A. Okay.
Q. It's Plaintiffs' Exhibit 25, page 402.
THE COURT: Which exhibit?
MR. HARVEY: Your Honor, I believe it's Plaintiffs' Exhibit 25, page 402.
BY MR. HARVEY:
Q. Have you found that page, Dr. King?
A. Yes.
MR. HARVEY: Have you found it, Your Honor?
THE COURT: Yes. Go ahead.
BY MR. HARVEY:
Q. Dr. King, there's a paragraph that starts with the word "Consider further use." Do you see that?
A. I do, yes.
Q. Can you read that paragraph into the record, please?
A. Sure. "Consider further use of quantitative statistical

analyses for understanding causality and the potential role of confounding factors. Because parametric procedures have been used successfully elsewhere to evaluate multivariate environmental data sets and can provide a relatively objective, quantitative framework for data analysis, a more rigorous statistical analysis should be contained in the document. Further, it would be helpful for the authors to clarify whether nonparametric multivariate methods, such as non-metric multidimensional scaling, were considered. At a minimum, the EPA document should discuss the pros and cons of multivariate statistical methods (such as multiple linear regressions, principal components analysis, and canonical correlations, factor analyses, and partial correlations) and explain why these approaches were not applied."

Q. Dr. King, do you know whether EPA addressed that concern?

A. I do believe it is addressed in the confounding factors discussion, yes.

Q. Can you point me to where that is?

A. Take a minute to find it. Do you know where it is or are you just asking me to find it or do you really not know where it is?

Q. I know where it is. I'd like to know if you know where it is.

A. Okay. JE 475.

MR. HARVEY: Can you pull up page JE 475? One

moment, Dr. King. We had that pagination issue again.

BY MR. HARVEY:

Q. I'm going to have Mr. Tyree highlight a paragraph on that page, and you tell me if we're talking about the same part of the document.

Dr. King, I've had Mr. Tyree highlight page 475, PE 475. Is that the same reference you're making?

A. Yes.

Q. Could you read that paragraph into the record?

A. Sure. "Some commenters recommended using multivariate statistics in place of weight-of-evidence analysis as the sole means to address potential confounders. However, because of the goals of the analysis and the nature of the data, it is not appropriate to use multivariate statistics alone to try to model the relationship between conductivity and extirpation or to eliminate the effects of confounders or estimate the magnitude of their effects. First, no statistical test can demonstrate that an association is causal. Second, violation of assumptions prevents reliable estimation of the influence of one potentially causal variable on another. Multiple regression depends on the assumptions of independence, additivity, and normality that are not met. In sum, multivariate statistical associations are just associations, and association is not causation. However, they can be used as evidence in the weight-of-evidence analysis along with

other incomplete or imperfect pieces of evidence to help reach the best-supported conclusion."

Q. Did EPA do anything beyond that paragraph to respond to the SAB's concerns?

A. I think the SAB's concerns were largely addressed via the fact that they did include statistical associations as part of the confounding factors analysis. You know, I mean -- so, to me, part of the comments that were made, just because SAB made that comment sounds like they didn't fully understand what they did in the confounding factors analysis, because they did do statistical associations as part of it and then used it as one of several different tools to address confounding factors.

So I think part of it is EPA did do a lot of what the people were asking for, but what they're saying here is it's actually not appropriate to try to use a multivariate approach to parse out a bunch of variance -- variables that each have potentially different distributions and are going to violate the assumptions, which is, in fact, the major underlying problem with using parametric techniques on ecological data, is that most of the time those assumptions that get violated and that's what EPA is saying here.

Lester Yuan, who is one of the authors of the benchmark document, is --

Q. Dr. King, that's well outside of what I asked you.

A. He's an expert in statistics, okay?

Q. Dr. King, did EPA do anything else besides adding this paragraph telling the SAB they didn't understand? Did they add anything else to their analysis?

A. As far as I know, other than what I just said.

Q. Okay. Dr. King, I'd like to turn next to Joint Exhibit 25, which is a table that you prepared and talked about with Mr. Becher.

I think in your discussion with Mr. Becher, you called this a very simple analysis; is that right?

A. Well, yes. It's simply meaning -- it's like an expanded contingency table, basically.

Q. Is this the type of analysis a trained statistician would use?

A. It's actually very simple. It's a tabular form of analysis, sure. This is supplementary to all the other things that I've done on top of it to basically show that even doing this, you come up with the same sort of conclusion.

Q. Is this analysis something a trained statistician would use?

A. Sure.

Q. Okay. You ran this analysis after removing sites with potential confounding factors, correct?

A. I did. I screened the data using the criteria outlined in the Bernhardt, et al. paper, the same criteria, and I used it -- applied it to the dataset.

Q. You removed sites that had high urban development, correct?
A. Well, not necessarily just high, even pretty low levels of urban development; basically only allowed sites that had minimal urban development.
Q. Low pH? You removed those as well, below 6, correct?
A. That's correct.
Q. High chlorides? You removed those sites, correct?
A. That's right. That's a different form -- a different mixture of ions.
Q. And sites with low RBP scores, correct?
A. Yeah, poor or marginal. So only suboptimal or optimal habitat.
Q. And you did not remove any sites based on temperature, correct?
A. Not in this analysis, I did not.
Q. Okay. Were availability of food, that wasn't factored in?
A. No data on availability of food, but the habitat index is a proxy for that.
Q. Okay. Or presence of valley fills, sites with valley fills weren't ruled in or ruled out?
A. Sites with or without valley fills? It's specifically looking at the conductivity that would be associated with alkaline mine drainage. We would -- I removed sites that had

high chloride. So that's pretty much the only other major source of high conductivity in West Virginia streams. So these would be sites that are associated with mines as conductivity increases.

Q. Did you analyze or deal with confounding relating to the presence of sediment ponds in this analysis?

A. Presence of sediment ponds, I didn't have -- there's no data that's associated with these sites about presence of sediment ponds, but both -- I think both EPA and the recent Pond paper demonstrated that that was not --

Q. You didn't do anything, did you, in this analysis?

A. Well, because, one, there's no data available; and two, others have already shown that that's not a confounding factor.

Q. You testified earlier about EPA's use of logistic regression. Do you recall that?

A. I believe, yes, I did.

Q. Okay. That was the testimony about conductivity at levels of 300 would have a 59 percent chance of failing. At 500 conductivity, I think your number was 72 percent. Is that correct?

A. Yes.

Q. You don't have access to the logistic regression model that EPA used, do you?

A. I don't.

Q. Okay. And you told me at your deposition that you don't have a lot of experience with logistic regression; is that correct?
A. I haven't used it much, no.
Q. Okay. Dr. King, you also testified about the paper that you co-authored with Dr. Bernhardt, "How Many Mountains," correct?
A. Yes.
Q. The Sierra Club funded that paper, correct?
A. I'm not sure where all the funding came from. I received no funding for it.
MR. HARVEY: Mr. Tyree, can you pull up Plaintiffs' Exhibit 2? And go to page PE 26.
BY MR. HARVEY:
Q. Dr. King, do you see the acknowledgment section? Can you read the highlighted section into the record, please?
A. Sure. "This research was supported by unrestricted gifts in support of research provided by the Foundation for the Carolinas and the Sierra Club to ESB." That would be Emily Bernhardt.
Q. Okay. Dr. King, I wasn't asking you about you or suggesting anything inappropriate. I just wanted to understand was this paper funded by the Sierra Club.
A. Well, I think in part. I mean, again, I put in a lot of hours on it and didn't receive any compensation. So some of

it was funded -- I guess should have acknowledged Baylor University because they were paying for my time.

Q. I'll leave that between you and Baylor, but was part of this paper funded by the Sierra Club?

A. Yeah, I guess part of it was.

MR. HARVEY: Okay. Mr. Tyree, can you go to the first page of "How Many Mountains"?

BY MR. HARVEY:

Q. There's a section highlighted there, Dr. King.

May I approach, Your Honor?

THE COURT: Yes, you may.

BY MR. HARVEY:

Q. Dr. King, I've highlighted a part of this, but if you would, read the part of the paper starting with the word "Pyrite."

A. "Pyrite minerals in coal residues release sulfuric acid, and the production of this strong acid within a matrix of carbonate bedrock neutralizes the acidity generated by pyrite dissolution and releases high concentrations of coal-derived sulfate ions accompanied by elevated concentrations of calcium, magnesium, and bicarbonate ions."

Q. Those are the same ions that EPA noted in the benchmark, correct?

A. Correct.

Q. Sulfate, calcium, magnesium, and bicarbonate, correct?

A. Yes.
Q. And I think in the *Elk Run* trial, you told us that bicarbonate was particularly important. Do you recall that?
A. I do. I believe that there's some evidence that bicarbonate is one of the factors that influences mayflies in particular, interferes with their ability to regulate sodium and chloride through their transport pumps.
Q. Okay. You also discussed the Kunz paper. Do you know how to pronounce that? Is it "Koons"?
A. I guess it's "Koonz." I don't know him personally.
Q. It's Plaintiffs' Exhibit 10. Do you still have that with you?
A. Okay.
Q. Now, I'd like to focus your attention to the very last paragraph -- scroll up, Mr. Tyree, if you would -- in this paper.
You and Mr. Becher talked about part of this paragraph, but I want to make sure we cover all of it. Can you read the first highlighted section, please?
A. "In the present study, 2 central ideas in the assessment of toxicity associated with major ions were reinforced: specific ion composition of the water is critical, and selection of laboratory test species is also critical for relating major ion toxicity to field data. For example, survival of *C. triangulifer* and *L. siliquoidea* was reduced in

all dilutions of Boardtree and Winding Shoals reconstituted waters in this case (with elevated magnesium, calcium, potassium, sulfate, and bicarbonate), yet *Centroptilum triangulifer* did not exhibit adverse effects with exposure to Upper Dempsey reconstituted water (with elevated sodium, potassium, sulfate, and bicarbonate)," which was neutralized water, by the way, "at conductivity comparable to the toxic dilutions of Boardtree and Winding Shoals reconstituted waters."

Q. So what this is telling us, in simpler terms, is that some high conductivity water kills mayflies; other high conductivity water did not kill mayflies in the study, correct?

A. Correct. So when it was not representative of alkaline mine drainage, it didn't have the effect. When it was, it did.

Q. And the water that killed mayflies contained high levels of magnesium, correct? It's there in the paper.

A. Yeah. I mean it contained levels of all of those same -- the four big ions that occur in alkaline mine drainage.

Q. Magnesium is mentioned in the paper there, correct?

A. Magnesium, sulfate, bicarbonate, and calcium.

Q. Okay. What analysis have you done to determine if Stillhouse has elevated levels of bicarbonate?

A. Whether it has elevated levels of bicarbonate? The data

from Evan Hansen I believe showed that it had elevated levels of bicarbonate, yes.

Q. Let's look at that.

Mr. Tyree, can you pull up table 2 from Mr. Hansen's paper?

A. I mean --

Q. Let's --

A. Okay.

Q. -- get to the table. It's Joint Exhibit 4.

Is this the table that you and Mr. Becher discussed earlier, Dr. King?

A. I don't think we discussed this table.

Q. It's been admitted into evidence. Is this sampling that was conducted at Stillhouse from Evan Hansen?

A. Yes.

Q. Is bicarbonate analyzed in this sample?

A. It's not, but --

Q. Is it analyzed in this sample?

A. It isn't because --

Q. Dr. King, is magnesium analyzed in this sample?

A. It is not.

Q. Thank you.

Mr. Tyree, can you pull up Joint Exhibit 60?

This is the document that you and Mr. Becher discussed earlier, Dr. King. Do you recall that?

A. I do.
Q. And you and Mr. Becher discussed a table at the very end of that document -- do you recall that? -- showing conductivity as a definite or a likely stressor?
A. Yes. Yeah, at above 1533 the state deems it as essentially definite.
MR. HARVEY: Mr. Tyree, can you go to that last page?
May I approach again, Your Honor?
THE COURT: Yes, you may.
BY MR. HARVEY:
Q. Can you read -- do you have this in front of you, Dr. King? This may be hard to read.
A. I can read it.
Q. You can read it? Okay. Can you read the section -- the sentence that starts -- part of the table that talks about whether conductivity is a definite stressor. It starts with the word "Consider." Do you see that?
A. Okay. "Consider as independent stressor in non-acidic, non-alkaline, non-acid-mining-drainage streams, when conductivity values met threshold ranges and sulfates and chloride violate conditions listed as follows."
Q. Okay. So the table is qualified by this condition, when conductivity levels are as high as in this table and sulfates and chloride violate the conditions listed below. So all

three have to occur, correct?
A. I don't believe that's what they mean because --
Q. Well, what does it say?
A. It doesn't make sense if sulfates and chlorides would violate the condition because they're usually in two different mixtures, so --
Q. But it says when all three of these conditions are present, correct?
A. I think it's a typo. I mean honestly I'm 99 percent sure that's not what they mean.
Q. Your testimony is this is a typo?
A. My testimony is that that makes no sense that they would say that. So if sulfates are above that level and conductivity is above that level, that makes sense. If chloride is above that level and conductivity is above that level, that makes sense, but not all three.
Q. Are there any other typos in the table?
A. I don't know, but I'm just telling you I'm confident that that's not what they mean. That's not how they employed it. Otherwise, it makes no sense.
MR. HARVEY: Mr. Tyree, can you go to Plaintiffs' Exhibit 8, the Suter and Cormier paper?
You may not have that, Mr. Tyree.
MR. TYREE: What's the title?
MR. HARVEY: I think it's Suter and Cormier on

causation.

THE WITNESS: What's the exhibit number?

MR. HARVEY: It's Plaintiffs' Exhibit 8, Dr. King. I have it here. Do you have it now, Dr. King?

THE WITNESS: I do.

BY MR. HARVEY:

Q. Mr. Becher had you read parts of this paper. Do you recall that?

A. Yes.

Q. In the first column on the first page, which is designated as PE 112 --

A. Yes.

Q. -- there's a paragraph that starts with the word "The method." Do you see that?

A. Yes.

Q. Would you mind reading that paragraph into the record as well?

A. "The method is applied to potential confounders of the relationship between stream invertebrate presence and the salts that leach from crushed rock in central Appalachia. The goal of the present analysis was to determine which environmental variables must be treated as confounders in the development of the benchmark value." Keep reading?

Q. No. Well, hold on. I think we've got it all.

No, sir. Continue with "It was not."

MR. BECHER: Where are we?

MR. HARVEY: PE 112.

THE WITNESS: Continue with "It was not"?

BY MR. HARVEY:

Q. Yes, sir.

A. "It was not to eliminate confounding variables. Most of them are natural variables, such as temperature and habitat structure, that cannot be literally eliminated, like eliminating women or smokers in an epidemiological study. Nor was the goal to equate the levels of confounders to an ideal or pristine level. Furthermore, the goal was not to demonstrate that these variables never cause effects. It is known that these factors all cause some effects in some circumstances. The goal was to support estimation of the ionic strength, measured as specific conductance, that protects against unacceptable effects on the invertebrate communities in those streams without significant influence by confounding variables."

MR. HARVEY: Thank you, Dr. King.

Your Honor, if I may have one moment, I think I can wrap up.

THE COURT: You may.

BY MR. HARVEY:

Q. Dr. King, one last bit of housekeeping, and I appreciate your patience with all the reading. It's a rule of

evidence --

A. Sure.

Q. -- and why I do it this way.

If we can go back to the Kunz paper, which is Plaintiffs' Exhibit 148 -- I'm sorry -- Plaintiffs' Exhibit 10, page 148. It's on the screen. It might be the easier way to do this. I'm going to have you read one highlighted part.

Can you read the last highlighted part from where you're sitting, Dr. King?

A. "Future studies should focus on identifying the primary toxic ions or, conversely, determine whether a characteristic ionic matrix is necessary to produce toxicity."

MR. HARVEY: Thank you, Dr. King. No more questions.

THE COURT: All right. We'll take a brief recess before we do any redirect. We'll stand in recess about ten minutes. You may step down.

(Recess from 2:04 p.m. to 2:17 p.m.)

THE COURT: Dr. King, if you'll resume the stand.

Mr. Harvey, you've finished your cross-examination.

MR. HARVEY: Yes, I have, Your Honor.

THE COURT: Redirect?

MR. BECHER: Thank you, Your Honor.

REDIRECT EXAMINATION

BY MR. BECHER:

Q. Hello again, Dr. King. I want to start with a fairly general matter. There were a lot of questions by Mr. Harvey about the influence of factors like the availability of nutrients, like flow, temperature.

Is it your opinion that those can never cause biological degradation in a stream?

A. No, that's definitely not my opinion. Of course they can.

Q. Okay. What happens when those factors are present along with very high conductivity?

A. You're saying if those factors are poor?

Q. Well, scratch that question. Would you expect any of those factors alone to lead to the complete extirpation of mayflies in Appalachian streams?

A. Well, for example, flow, if the stream channel is dry, I'd say yes, that's going to be a complete extirpation. But, you know, even a moderate change in flow status would certainly not lead to the extirpation of mayflies.

You know, food availability is kind of an odd question. I mean it's -- you know, the streams sort of are driven primarily by what are called lichenous inputs, you know, essentially leaves, material falling into the stream by vegetation along the stream. And so we know there's vegetation along the stream, including trees, and we know that leaves get in there. And hence, you know, I was asked whether

I could -- whether I knew anything about that or whatever. I think it's clear that, you know, that alone is not driving the response there, no.

So -- but, no, I think none of those factors, unless -- what was the third factor that you discussed?

Q. I think I said flow, nutrients, and temperature.

A. Yeah, temperature. Well, temperatures at the levels that we've see obviously I don't think have any real marked effect on the community.

If the temperature were 40 degrees Centigrade, yes, it would cause a complete extirpation. So it's a matter of the magnitude of the variable that we're talking about.

Q. Mr. Harvey also had a line of questions about the different toxicities of different suites of ions.

To respond to that, can you turn to Exhibit 58, the benchmark, the front of the benchmark. So it will be in the first joint exhibit notebook.

A. Okay.

Q. And I want to look at the executive summary, which is on JE 381.

A. Okay.

Q. I believe -- well, can you read that first sentence for me?

A. "This report uses field data to derive an aquatic life benchmark for conductivity that can be applied to waters in

the Appalachian Region that are dominated by salts of calcium, magnesium, sulfate, and bicarbonate at circum-neutral to mildly alkaline pH. The benchmark is intended to protect the aquatic life in the region."

Q. You can stop there. My question is, so this benchmark is talking about conductivity with those specific suites of ions; is that correct?

A. Yes.

Q. And in reviewing the benchmark and reviewing the data that you've worked on for "How Many Mountains" and this case, is that constituent suite of ions fairly consistent in alkaline mine drainage?

A. Oh, very. And so, for example, in Evan Hansen's table of data, the bicarbonate wasn't, in fact, in there, but calcium was. And calcium, it's calcium carbonate. It's the dissolution of those. So when you have a certain concentration of calcium, you necessarily have a certain concentration of bicarbonate. So it's implied. So he didn't measure it because he measured the calcium. So we know how much bicarbonate was there.

Q. Is that because of the source of the calcium and bicarbonate?

A. Exactly, and it's the dissociation, the dissolution of calcium carbonate into those component ions. They're balanced. There's an equilibrium there. So if you know how

many bicarbonates we have, we know how many calciums we have. And there is a lot of calcium.

Q. Thank you. While we're on this, let's go back to the Kunz paper, which is in the plaintiffs' exhibit folder. I believe it's Exhibit 10 of plaintiffs' exhibits.

And Mr. Harvey took you through this last paragraph where it talked about these species responding to Boardtree and Winding Shoals and I believe not responding as significantly to water from Upper Dempsey. Do you recall that?

A. Yes.

Q. Will you remind the Court again where Boardtree is?

A. Boardtree is immediately adjacent to Stillhouse Branch. The watersheds actually are just, you know, separated by a divide. They touch each other.

Q. Would you expect the water in Stillhouse Branch would be more like this water in Boardtree or more like the water in Upper Dempsey?

MR. HARVEY: Objection; foundation.

THE COURT: Well, lay more of a foundation.

MR. BECHER: Okay.

BY MR. BECHER:

Q. Based on where you know -- what you know about the locations of these two streams, Boardtree and Stillhouse, would you expect their water chemistry to be similar?

A. Yeah. I mean it definitely would be similar. I mean

they're coming from the same rock, same parent material.

Q. Thank you. There were several questions about your use of snapshot temperature data and criticism, I think, of your referring to that as almost useless in the last trial.

Can you, for the Court -- I want to give you a chance to explain this more fully. When do you think that this kind of snapshot data is indeed useless and when may it be useful in an analysis?

A. Well, I -- for example, I wouldn't go to the table and look at a site, an individual site, and see a temperature of, say, 15 degrees C and just without knowing when it was collected and time of day -- even if I knew that, I wouldn't assume that I know the thermal regime at that site. And I wouldn't use that to try to compare it to, say, another site and say, well, this site that has a temperature of 15 versus this site that has a temperature of 12, I wouldn't go -- I wouldn't be willing to say that the two necessarily are different.

However, it's useful to know, for example, when -- if you have a high temperature, just like when we have a very high conductivity reading, we know that sometimes conductivity readings can be low because of dilution. But when it's very high, you know, you've got -- I mean very rarely do you have very high conductivity just once and then the rest of the time it's low.

So in the case of temperature, when you have high temperature values at a stream, it's indicative of a stream that probably has higher than average conductivities. So there's an example where that would be useful information.

It's also useful when you have a very large dataset and you have many, many, many observations, and so you have co-occurrence of temperature data and conductivity data. So you have lots of sites that have high conductivities but that some of them might have low temperatures and some of them might have high temperatures. In the cases where you have the high temperatures and high conductivity versus low, that's where it allows you to assess whether or not potentially those high temperatures are having a confounding effect. And given that we simply don't see relationships with high temperature and mayflies, for example, it really calls into question -- I think completely refutes the idea that temperature is, you know, driving this relationship.

Again, we're talking about principal cause here. And it is to me unequivocal that conductivity is the principal cause. And I think it's so weak, the relationship between temperature and the biological data and the very weak correlation between temperature and conductivity. To think that that temperature is the principal cause is -- there just is no evidence to suggest that it is.

Q. Is that what you were making a point in your graph on the

figure from your expert report, which is Joint Exhibit 32?

A. Precisely.

Q. I want to -- may I approach?

Do you recognize this document, Dr. King?

A. I do.

Q. Is it your expert report?

A. Yes.

Q. Mr. Harvey walked you through your expert report where you talked about the correlation coefficients in the exhibit we were just talking about.

A. He did, yes.

Q. You said you drove home the point later on, and I don't think you were allowed to refer to that during cross.

Were you referring to this sentence below the chart, starts with "Based on the West Virginia dataset"?

A. Yes. May I read it?

Q. Absolutely.

A. "Based on the West Virginia dataset, at the temperatures recorded by Dr. Menzie, I would expect there to be at least five to ten genera of mayflies at a site like Stillhouse Branch. The complete absence of mayflies and abundance of conductivity-tolerant taxa informs my conclusion that it is conductivity and not temperature leading to biological impairment."

And I don't believe I'm referring to correlation

coefficients there in making that conclusion.

Q. So you're not relying on correlation coefficients alone for your opinion?

A. No, I mean absolutely not.

Q. If I could again refer to Joint Exhibit 32, I believe again you started to talk about why you limited that to summer data.

Is there anything else you want to offer as an explanation of why the limitation of these data to summer only data is appropriate?

A. Well, one of the factors as well is that there's seasonal patterns in the emergence of certain taxa, and whereas, you know, the WVSCI apparently, you know, accounts for seasonable differences in the way they calculate their metrics and score them, individual taxa, for example, are -- like a lot of the mayflies, often are very abundant in the spring and then more or less disappear in the summer.

And so it sort of confounds the analysis to mix spring and summer data together in looking at, for example, taxa responses or things of that nature. So confining it to summer data, it's just a way of removing that potential confounding effect.

Q. Okay. Now, I want you now to compare the plots in Joint Exhibit 31 with 32. I believe you said that the, you know, the trend line in Exhibit 32 wasn't a key or wasn't the

principal component of what you tried to express with this graph.

The significance in this, I mean is that obvious just by looking at the scatter distribution between these two graphs?

A. So, again, referring to page JE 113?

Q. Uh-huh.

A. Yes. So the scatterplot alone, visualizing the data, it's very clear that the relationship is very weak. And this is just a trend line that was fitted there. And, yes, there is an equation with variance explained associated with it, but other techniques would -- you know, again, I did not include other diagnostic statisticals such as p-values.

You know, had I gone that far, then there would've been some violations of assumptions on doing the trend line here. But the graph itself is -- and the point I'm making with this graph is just simply look at the data. You don't need a correlation to say -- to point at a dot that says 10 taxa at a temperature of roughly 28 degrees, and in many, many, many cases of above 24 degrees, 25 degrees, where we have, you know, five, six, seven, eight genera. That's the main point of this graph. Whereas, the other graph, which also has a trend line fitted to it -- and it's a non-linear one, a polynomial because the relationship is very non-linear, does show a high variance explained. But, again, you could simply just look at it. You don't need the trend line to see that

basically as conductivity increases, there's a dramatic collapse in the number of mayfly taxa.

So I mean I could show this to my 11-year-old son and ask him, "What do you see," and he would undoubtedly see, well, it looks like there's low numbers on this side and there's high numbers on that side. I mean they're markedly different. It's the same data.

Q. Now, along with the criticism of the correlation coefficients, I think there was some criticism of the benchmark's use of correlation coefficients.

Can you -- we discussed this earlier, but in light of the questioning, would you return to table B-20. That's the benchmark again, Joint Exhibit 58. I'm looking at page JE 493.

MR. HARVEY: I'm sorry, Mike. Which exhibit?

MR. BECHER: It's in the benchmark. JE 493 is the page number.

THE WITNESS: Okay.

BY MR. BECHER:

Q. Are correlation coefficients based on the explanation here by the EPA the only factors that are used to rule out confounding?

A. No.

Q. Okay.

A. They use several.

Q. There was a question to you regarding the SAB comments about multivariate statistics. Do you recall that?
A. Yes.
Q. Did they use multivariate statistics to help rule out confounding here?
A. They did.
Q. Okay.
A. They included multiple predictors in a model and assessed how much it changed the model by including those variables, and it had a negligible effect on the relationship.
Q. While we're on the topic of the SAB -- I believe that was Plaintiffs' Exhibit 25. Can you return -- it's 27. Let me make sure I get this right. Yeah, Plaintiffs' Exhibit 25.
A. Okay.
Q. If you could turn to page PE 374.
A. Okay.
Q. You recognize that some of the people on this I believe that you said you thought have a pretty good foundation or perhaps even be experts in statistics; is that right?
A. In the statistics that are relevant to the analysis in the report, absolutely. Almost all of them do.
Q. Do you know everyone on this list?
A. No, I don't know all of them.
Q. Can you turn to PE 376. I think PE 374 where Mr. Harvey had you look at was the panel that reviewed the benchmark. I

believe PE 376 is the Scientific Advisory Board itself.

Do you know everyone on this list?

A. I know about half of them.

Q. Okay. Would you consider them to be good scientists?

A. Yeah.

Q. Is there anyone that you could point out as an example that would have good knowledge, perhaps be expert in statistics?

A. Yes. I mean I think, for example, David Dzombak. He was actually the editor of the "How Many Mountains" paper. And, yes, again, he's very familiar with mining issues, and he's in environmental engineering, which is a very quantitative field. And he had -- you know, obviously he didn't have much problem with our use of statistics in that paper.

Q. I believe you were going to say something about a Dr. Yuan.

A. Oh, Lester, Dr. Lester Yuan. He was one of the main contributing authors of the benchmark document, and he is a -- his degree is in statistics. He is a statistician. He's more of a frequentist, I believe, but he is definitely an expert in statistics. In fact, all of his publications deal specifically with applications of statistics in ecological and environmental science.

Q. Now, there were also some questions about your background in statistics. You're an ecologist, correct?

A. Yes.
Q. And what's your department?
A. Biology.
Q. Okay. Do you do any work with -- well, let me ask first, is there a Department of Statistics at Baylor?
A. Yes.
Q. Do you do any work with the Department of Statistics?
A. Yes. In fact, I even had a statistician sit in on my R course because he was interested in learning some of the ways that we're using R in graphical analysis of data. And I've sat on two committees in the Department of Statistics as well.
Q. So you're certainly conversant in basic statistics?
A. Oh, certainly.
Q. But you have a particular expertise, again, in ecological statistics?
A. Yes, exactly.
Q. Okay. There was also brief mention of Sue Qian. And this also came up in deposition. Could you give us a brief overview of the situation with Dr. Sue Qian and the TITAN analysis in the "How Many Mountains" paper?
A. Yeah. Song Qian.
Q. Sorry.
A. That's all right. Well, very briefly, Song has a different approach to collegiality, I guess you could say, and is -- instead of -- I don't know, you know. His critique of

our analysis, our TITAN analysis, was based almost entirely on the fact that he was employed by the U. S. Geological Survey, by, I believe, a regional program leader named Tom Cuffney. And I, along with Matt Baker, had written a paper that we -- where we critiqued a publication that was led by Tom Cuffney. And we simply pointed out that you could come up with a different conclusion in their analysis by looking at the data in a different way.

And one of the ways we looked at it was with TITAN, but not just that. We also looked at the data by some other techniques.

So apparently that caused more of a problem for Tom, whether it be him -- his ego or whether it actually was a problem, you know, in his job. I don't know. But he was very upset. And Song was not an author on the paper that we critiqued, but they in turn turned around and Tom basically paid Song to tear apart TITAN.

Q. What was the end result of that? Was there any resolution in the literature?

A. There was. The resolution was that our -- our paper was a response to their critique, and our paper unequivocally addressed every one of their points and completely dismantled them. And that's not just my words. That's the words of the editor of the journal --

MR. HARVEY: Objection; hearsay.

THE COURT: Sustained.

MR. BECHER: Certainly.

THE WITNESS: And I guess the proof is TITAN has, you know -- we say let it play out in the literature. Well, it's played out in the literature, and TITAN is being used more than it ever has.

BY MR. BECHER:

Q. Thank you. I want to ask you to turn to Defendant's Exhibit 8. And that is the Total Maximum Daily Loads for Streams in the Gauley Watershed, West Virginia, the final approved technical report.

A. Defendant's Exhibit 8?

Q. Yes.

THE COURT: It's in volume 1 of Defendant's --

THE WITNESS: Excuse me. Sorry about that.

BY MR. BECHER:

Q. If you could turn to page 12 of that exhibit.

A. I'm not sure I'm looking at the right thing here. This is a causation paper?

Q. I can put it on the document viewer.

MR. HARVEY: Mike, we're lost too. Which page are you on?

MR. BECHER: Defendant's Exhibit 8, the Gauley TMDL technical report.

THE WITNESS: I think I've found it now. There's a

lot of notebooks. Okay.

BY MR. BECHER:

Q. If you recall, there was some question as to the interpretation of language by the DEP about what is necessary to be an ionic stressor; is that right?

A. Yes.

Q. Will you read on page 12 the point 4, the last row, the first column under Ionic Strength.

A. So --

Q. "Consider as independent stressor in non-acidic, non-AMD" --

A. Yeah. "Conductivity. Consider as independent stressor in non-acidic, non-acid-mine-drainage streams, when conductivity values exceed elimination thresholds and sulfates and chloride violate conditions listed as follows."

Q. Is that the same language as in the other document that you were having interpretation questions with?

A. I think so.

Q. Okay. If we need to, we can refer back to that.

Well, the record will show whether that's the same language or not. But you had said that you did not think that chloride had to exceed a certain amount because that would not make sense.

A. Well, it didn't make sense to me that both would have to be, because of the mixture of ions. I mean you're usually

dealing with -- high chloride is usually associated with Marcellus shale brines, and then -- or road salts. And so you're not going to have the high sulfates in that situation. And then, of course, in an alkaline mine drainage case, we don't have high chlorides. On a case you'd have to have both, and there's very few situations you'd ever have both of those together.

Q. Do you recall if we had high chlorides in Stillhouse Branch?

A. I don't think there are high chlorides there, no.

Q. Can you now turn to page 15 of this document?

A. Okay.

Q. Can you read the first sentence of the last paragraph?

A. "In certain waters of the Gauley River, (Scrabble Creek, Left Fork/Scrabble Creek, Boardtree Branch, Sugarcamp Branch, Stillhouse Branch, and Robinson Fork), the stressor identification process determined ionic toxicity as the primary stressor."

Q. So this -- does this support your interpretation that it's --

A. Yes.

Q. -- that DEP has identified --

A. Yes. That's why I was saying it had to have been -- one of those two had to be high. It made no sense otherwise.

MR. BECHER: One moment, Your Honor. Nothing

further, Your Honor.

THE COURT: All right. Recross?

RECROSS EXAMINATION

BY MR. HARVEY:

Q. Dr. King, I believe you told Mr. Becher that you would expect the water to be the same in Boardtree as in Stillhouse, correct?

A. I'd expect the relative mixture of ions to be similar. I didn't say exactly the same.

Q. Do you know what coal seams were mined in the Stillhouse Branch watershed?

A. Which specific coal seams?

Q. Yes, sir.

A. No, I don't.

Q. How about at Boardtree? Do you know what seams were mined resulting --

A. I don't recall. I think I did at one point, but --

Q. Mr. Becher showed you some individuals who were not on the SAB panel but on the entire full SAB that included epidemiologists and statisticians.

Do you recall that?

A. Yes.

Q. Do you know whether the entire SAB reviewed the benchmark, or did the panel simply review the benchmark?

A. I don't know for sure whether or not the entire SAB,

Science Advisory Board, reviewed it. I don't recall.

Q. Okay. I'm going to point you to Plaintiffs' Exhibit 25, page PE 385.

Mr. Tyree, can you pull that up?

We'll make do, Dr. King, without the screen. On page 385 there's a paragraph that describes the process. Do you see that? It says the panel met on July 20th through 22nd. Do you see that?

A. I do.

Q. Okay. And midway through the paragraph, it says the panel held a follow-up public teleconference on October 20th, 2010, and the SAB conducted a quality review of the panel report on January 19th, 2011. Do you see that?

A. Yes.

Q. Is it possible that the panel reviewed the benchmark and then the SAB reviewed the panel's report?

A. I mean it's clear that the panel reviewed the benchmark in detail and that the board reviewed their assessment of it. But earlier it says that the two technical documents mentioned above were sent to the Scientific Advisory Board for review.

Q. Right. And then the panel reviewed them, correct?

A. Well, it says it was sent to the SAB for review. So it may be that they reviewed it and then sent it out to the panel for their comments and then they reviewed their comments. It's really ambiguous to me in reading this.

Q. Okay. You talked about the fact that at certain high temperatures, you found some mayflies in the data; is that correct?

A. Yeah. You saw the graph that showed that that was the case.

Q. Right. I'm going to ask you to turn to Joint Exhibit 43, which is a stipulation of the parties. I can put it on the Elmo, I think.

Do you have Joint Exhibit 43, Dr. King?

A. I do.

Q. And it describes a dataset taken from "How Many Mountains Can We Mine?" Do you see that, in paragraph 17? I'm sorry.

A. Paragraph 17?

Q. Yes, sir.

A. Yes.

Q. Okay. And it mentions that --

MR. BECHER: Judge, I'm going to object. I think this is beyond the scope of redirect. This is a new document.

THE COURT: I can't see what you're starting to ask about in the stipulation. So I can't tell.

MR. HARVEY: I don't know if we can get it on the screen or not. We were having trouble pulling it up a second ago.

Your Honor, it is Joint Exhibit 43.

THE COURT: Which paragraph?

MR. HARVEY: Paragraph 17, Your Honor.

THE COURT: Okay. Explain to me how your questioning about this relates to the redirect.

MR. HARVEY: Your Honor, it is simple. He found mayflies at high temperatures, and he considers that important. This exhibit shows that there are passing WVSCI scores at high conductivity, very similar. There are some examples of every piece of evidence --

THE COURT: All right. I'm going to allow it since it's cross-examination.

BY MR. HARVEY:

Q. Paragraph 7 is ordered by habitat. Do you see that, Dr. King?

A. I do.

Q. It starts with marginal and it worked its way --

A. Yes.

Q. -- to optimal. Do you see that?

A. I do. And, interestingly, all these -- looking through marginal habitat here, all of them have mayflies.

Q. I'd like to talk to you about some of the optimal habitats towards the end. This is on page 13 of the stipulation.

A. All right.

Q. My apologies. It's not showing up very well on the Elmo. Do you see the one towards the bottom named Spruce Fork,

third from the bottom?
A. Yes.
Q. It has an optimal habitat, correct?
A. It says optimal, yes.
Q. And it has a conductivity of 608. Do you see that?
A. Yes.
Q. And it has a passing WVSCI score. Do you see that?
A. Of 69.33, yeah. That's pretty close.
Q. Can you turn the page? Maybe the one, two, three, four, sixth line down, there's a site for the unnamed tributary of Laurel Creek. Do you see that?
A. Yes.
Q. And this site has an optimal habitat, correct?
A. Yes.
Q. And WVSCI at 363. Do you see that?
A. The conductivity was 363.
Q. I'm sorry. Conductivity. WVSCI is 71.73. Do you see that?
A. Yes. Right near the edge.
Q. How about Buckles Branch?
A. Buckles Branch has 81.3, with very high conductivity of 1650.
Q. Most of these sites with optimal habitat have passing WVSCI scores, correct?
A. Yeah. Some do not, but --

Q. How many? I count two.
A. Well, there aren't very many that have optimal habitat either.
Q. Okay. Well, if we were going to use your pass/fail type of chart, roughly how many optimal habitats do you think we'd have here?
A. Maybe 20.
Q. Okay. And how many fail at optimal habitat?
A. Yeah, there's like two or three.
Q. Okay.
A. But there aren't very many that have elevated conductivity. There's only one, two -- there's really only three that I would consider -- I mean there's one that has 363, you know, but that's kind of on the margin, and so there's only three that have elevated conductivity in that group. So I'm not sure what your point is.
Q. And they pass?
A. Those barely pass.
Q. 81 is barely passing?
A. Well, two of them barely passed, yeah.
Q. Okay. I understand that you feel that you won the battle with Song Qian in the papers that went back and forth, but Dr. Song Qian's papers were peer-reviewed; is that correct?
A. Sure.
MR. HARVEY: One moment, Your Honor.

THE COURT: All right.

MR. HARVEY: Thank you, Dr. King. No further questions.

THE COURT: All right. Any redirect?

MR. BECHER: I'll be very brief, Your Honor.

FURTHER REDIRECT EXAMINATION

BY MR. BECHER:

Q. I just want to make one clarification point about the SAB panel and full SAB review. I think you said it was ambiguous whether the SAB reviewed the entire benchmark or not.

Is there any doubt that they reviewed the panel's report?

A. No. It's --

Q. So --

THE REPORTER: I'm sorry.

THE COURT: One at a time.

BY MR. BECHER:

Q. Sorry. Go ahead.

A. It's clear that they reviewed the panel's comments, their report, and it is implied that initially the board reviewed the benchmark document.

Q. Okay. Thank you. Mr. Harvey was bringing you through some of the data from, I believe, your "How Many Mountains" paper.

Did any of the data he pointed out change your mind?

A. No. And, you know, I think a very critical point has

been -- I don't think I have yet discussed it, but from the 2014 Pond et al. paper, there are cases with some of these points where you have a high conductivity and a passing WVSCI score. They examined that. They actually had a few cases where they had high conductivities and good bug data. But they identified the reason. And the reason was, in every case they examined, there was an unmined tributary that was contributing drifting organisms. Sometimes 4,000 organisms would drift into the mine channel per day. And so the unmined tributary had very good biological condition.

And so it illustrates that there is a mechanism that explains this. And so you have a source, these tributaries, and then the mined site becomes a temporary place for these organisms. They -- you know, as I suggested in the past, I think that it's mostly a chronic stressor. It doesn't kill them immediately. And so when they go and they collect, they get these organisms that are actually from a different place. And without those tributaries, you don't see those scores. And that's a major conclusion of the Pond 2014 paper.

MR. BECHER: Thank you.

THE COURT: All right. Any other questions?

MR. HARVEY: One, Your Honor.

FURTHER RECROSS EXAMINATION

BY MR. HARVEY:

Q. This data in paragraph 17 is from your paper, correct,

"How Many Mountains Can We Mine?"

A. It says so, yes.

Q. Do you know whether these sites we talked about had tributaries feeding clean water into these streams?

A. I don't know.

MR. HARVEY: No further questions.

THE COURT: All right. Any other questions for Dr. King?

MR. BECHER: (Shakes head from side to side)

THE COURT: Thank you, Doctor. You may step down.

All right. Mr. Becher?

MR. BECHER: Plaintiffs rest.

THE COURT: All right. The plaintiffs have rested.

MR. BECHER: Oh, excuse me. I neglected to move plaintiffs' exhibits. If we could, may I suggest we can move on and I can gather together the folders of exhibits and I'll introduce them before we leave today?

THE COURT: That's fine with me.

MR. BECHER: May we also un-sequester our witnesses, Dr. Palmer and Dr. Prestegaard?

THE COURT: You may.

All right. Mr. Harvey, are you ready?

MR. HARVEY: Your Honor, at this time actually we would like to move for a directed verdict.

THE COURT: All right. Go ahead.

MR. HARVEY: Conductivity is not a pollutant. It's a surrogate. It is a condition like humidity. It is a measure of ions which you have heard throughout these first two days of testimony are harmful, according to the evidence put on by the plaintiffs. Those ions include calcium, magnesium, sulfate, and bicarbonate.

The plaintiffs have introduced all of their chemical data. It does not include bicarbonate. It does not include magnesium. Two of the four fingerprint ions that are important to the EPA benchmark, to the paper that Dr. King did, we do not think they can make their case without that evidence.

Under the law they have to show that a pollutant is causing a violation of West Virginia's narrative standards. They have left out two of the primary pollutants that they claim is part of some mixture that is harmful.

THE COURT: All right. Response?

MR. LOVETT: Your Honor, we know from the evidence at Stillhouse itself that sulfates are extremely elevated, over 2000, and I think the testimony showed that 50 is the level of concern. We have levels -- we saw data showing -- data sheets showing sulfates elevated well over 2000.

Dr. King just testified that calcium was also very high in Mr. Hansen's list of constituents of the water and that that of the breakdown. That bicarbonate shows that

bicarbonates are high. The calcium number itself shows that calcium is high. And we also know that conductivity is extremely elevated. All of the samples I think were over sixteen or seventeen hundred, and many over two or three thousand.

I also think it's a question about whether conductivity itself is a pollutant. I think that's a legal question that hasn't been briefed here. We believe it is a pollutant. Mr. Harvey has done nothing to show that it's not a pollutant. It's a material, the concentration at which this case causes harm to aquatic life, impairment.

And, similarly, pH has been deemed to be a pollutant, and it similarly is an indicator of other problems with -- it's an indicator, just like conductivity, yet it is certainly a pollutant.

So we know that the WVSCI scores are failing, that the water is impaired here. We know that at this site, sulfates are high, calcium is high, bicarbonates are going to be high. So we know that the conductivity is high, and, of course, we have much evidence showing that when conductivities, sulfates, bicarbonates, and calcium are high, that that is a cause of the impairment that we see here.

We see no mayflies at this site, and that can only be explained by the conductivity and its associated ions.

THE COURT: All right. Mr. Harvey, do you want to

reply?

MR. HARVEY: Your Honor, I believe they said themselves, as did EPA, that conductivity per se is not a pollutant. The important thing is the mixture of the ions.

They have failed -- and I don't think they deny -- to introduce any evidence about two of them, bicarbonate and particularly magnesium.

I understand that Dr. King said there's some relationship between calcium and bicarbonate. I'm not sure they've proved it up. There's been nothing whatsoever introduced in the way of magnesium, which is a difference-maker. It is one of the four principal ions listed in every study they've put into evidence, Your Honor.

THE COURT: All right. I'm going to take this under advisement. I want to consider your arguments. While we're here, let's go ahead and start with the defense case.

MR. HARVEY: Your Honor, defendants call Carrie Kuehn.

THE COURT: All right.

MR. HARVEY: Your Honor, can Mr. Tyree set up a --

THE COURT: Yes, he may.

If you'll step up here, my clerk will swear you in.

CARRIE KUEHN, DEFENDANT'S WITNESS, SWORN

MR. HARVEY: Obviously we need someone who's not a lawyer to set this up. We'll do the best we can.

MR. LOVETT: Also, Your Honor -- excuse me, Shane. Sorry. I don't know what that's going to be used for, but we can't see it.

THE COURT: Are you going to use it? Do you want your witness to use this to write things?

MR. HARVEY: There will be a couple of occasions where she will do that, Your Honor. I don't know of a good location where the Court can see it and the plaintiffs can see it.

THE COURT: Well, I'm not sure either. I'm concerned about our ability to hear the witness without the microphone if she moves from the witness stand. I don't know if there's a way of setting that up up here. I can't tell from the base of it whether there's room. I don't know how much you're going to use it. So I don't have an easy solution.

THE WITNESS: It might fit, but we could try back here.

MR. HARVEY: Your Honor, what we will do is during the trial, we'll be holding it for Ms. Kuehn.

THE COURT: We could have Mr. McLusky lift it up over here. He's not doing anything.

MR. HARVEY: He may not be tall enough, Your Honor.

THE WITNESS: I could draw on it and then hold it up.

MR. HARVEY: Let's do that.

THE WITNESS: Okay.

MR. HARVEY: If we happen to have a break, Your Honor, we'll fix that.

THE COURT: That's fine.

MR. HARVEY: My apologies. During all that, I didn't see if Miss Kuehn was sworn in. I'm sorry.

THE WITNESS: I was.

THE COURT: She was.

DIRECT EXAMINATION

BY MR. HARVEY:

Q. Miss Kuehn, can you state your name for the record, please.

A. Carrie Kuehn.

Q. And where are you employed?

A. I'm employed at Exponent, Incorporated.

Q. And what do you do at Exponent?

A. I am a senior managing scientist in our biomedical engineering practice.

Q. And how long have you been so employed?

A. It will be six years this October.

Q. And what does a senior scientist at Exponent do in your field?

A. Senior managing scientist.

Q. Managing scientist.

A. I consult with clients. I work with -- I direct -- supervise, direct reports. I help manage the practice. And I do consulting work with a variety of different clients.

Q. Are you an epidemiologist?

A. Yes, I am.

Q. What is epidemiology?

A. Epidemiology is the study of the effect of the exposures on outcomes. We primarily use statistics as our main tool for conducting epidemiologic research.

Q. You said "we." Do you use statistics in your day-to-day work?

A. Yes, I do.

Q. Are you a trained statistician?

A. Yes, I am.

Q. Do you frequently examine observational data to reach conclusions of general causation or inferences about general causation one way or the other?

A. Yes. I've used many different types of observational data and conducted statistical analyses on them to examine the causal effect of an exposure on an outcome. We don't always infer causation based on just one analyses, but we look at the effect of the exposure on the outcome. So, yeah, I do that a lot.

MR. HARVEY: May I approach, Your Honor?

THE COURT: You may.

BY MR. HARVEY:

Q. Miss Kuehn, I've handed you what's been marked as Joint Exhibit 67. Is that your resume?

A. Yes, it is.

Q. Does it appear to be an up-to-date copy of your resume?

A. Yes. It looks relatively recent, yeah.

Q. Okay. On page 3 there's a section entitled Academic Credentials and Professional Honors. Do you see that?

A. Yes, I do.

Q. I see that you have a bachelor of arts degree in anthropology from the University of Washington.

A. That's correct.

Q. Now, tell me about that degree.

A. I primarily studied human biology. So it was a focus on physical anthropology, which is the study of humans. I did extensive undergraduate coursework in basic science, chemistry, biology, anatomy, physiology, statistics, and anthropology.

Q. Lawyers often take or major in political science in undergrad before becoming lawyers. Do epidemiologists frequently major in anthropology on their way to becoming epidemiologists?

A. Yes. I know a number of epidemiologists who began their college careers in anthropology.

Q. I see you also have a masters in biocultural

anthropology; is that correct?
A. That's correct.
Q. Did you tell me you were pursuing that at the same time you received your masters in public health and epidemiology?
A. That's correct. I studied -- I did both degrees concurrently over a three-year time period.
Q. And I believe I read online that the University of Washington is one of the top epidemiologic schools in the nation; is that correct?
A. That's correct. It's a world-class institution for epidemiology.
Q. And I see here from your resume that you have authored or co-authored several articles in the field of epidemiology; is that correct?
A. That's correct.
Q. Do these articles involve reaching conclusions from observational datasets?
A. Yes, they do.
Q. Do they involve the use of statistics?
A. All of them do, yes.
Q. Were these articles peer-reviewed?
A. Yes, they were.
Q. How many statistics classes did you take on the way to getting your anthropology and epidemiology degrees?
A. At least ten, the majority of which were graduate-level,

high-level statistics or biostatistics courses.
Q. Biostatistics?
A. That's correct.
Q. Can you give us examples of some of the courses you took?
A. I took applied ecologic methods, which is essentially the application of statistics to an epidemiologic question. I took fundamental epidemiology methods, which involved statistics throughout the training. I took advanced courses in logistic regression as well as survival analysis, just to name a few examples.
Q. And it appears here that you frequently -- I'm looking at pages 5 and 6 and 7 of your resume, and 8. You frequently present on topics involving epidemiology?
A. That's correct.
Q. Are you a member of any epidemiological societies?
A. Yes, I am.
Q. Tell the Court what those are, please.
A. I am a member of the International Society for Pharmaco-epidemiology. I'm also a member of the Society for Epidemiologic Research.
Q. Prior to being employed at Exponent, where were you employed?
A. I was employed in the pharmacoepidemiology group at Amgen, which is a biotech company.
Q. How many years in total do you have in the practice of

epidemiology?
A. More than 12 years.
MR. HARVEY: Your Honor, at this time I would move to admit Carrie Kuehn as an expert in epidemiology.
THE COURT: I'm satisfied. Do you want to --
MR. LOVETT: Well, Your Honor, we're not satisfied, but --
THE COURT: I'll let you cross-examine her about her qualification.
MR. LOVETT: Now or --
THE COURT: No, after we go through it.
MR. LOVETT: Okay. Thank you.
BY MR. HARVEY:
Q. Miss Kuehn, is epidemiology used to examine issues of general causation?
A. Yes, it is.
Q. How?
A. We use observational data to examine associations between exposures and outcomes. We cannot typically observe the cause and effect relationships that we're interested in. So we use a variety of statistical techniques to analyze observational data to evaluate the exposure and outcome relationships of interest.
Q. Does epidemiology examine associations between variables such as the association between smoking and lung cancer?

A. Yes, it does.
Q. How are associations measured?
A. Associations can be measured using a variety of statistical techniques. Some statistics are best for exploring data to try and get a sense for what your data looks like.

Others are designed to examine the -- or measure the effect of a variable, like an exposure, on another variable, like an outcome.

Q. Can associations be measured with correlation coefficients?
A. Yes, but in a very limited way.
Q. What is a correlation coefficient? I know we heard Dr. King talk about those. Explain to the Court what a correlation coefficient is.
A. A correlation coefficient tells you if the values for two variables move in the same direction or in opposite directions. The value of the correlation coefficient tells you how close those two variables or the values for those two variables are to a straight line. That's all that value tells you. It's usually denoted by a small letter "r," and that's about it. That's about all I can tell you.
Q. And according --

MR. LOVETT: Your Honor, this is beyond the scope of her report. There's nothing in her report about background or

coefficient correlation or -- we're outside the scope of her expert report.

THE COURT: As I recall her report -- I don't have it in front of me, but she provided her opinion criticizing reliance upon the correlation coefficients that are cited in these studies. I think she can certainly explain what these evaluations mean. Overruled.

BY MR. HARVEY:

Q. And "r" is usually measured somewhere between zero and 1; is that correct?

A. That's correct.

Q. And a correlation coefficient of zero would be a scatterplot of data with no relationship to the line drawn through it?

A. Yeah. I can draw a picture if you'd like. But, yeah. So a correlation of zero would essentially be a graph with a bunch of dots that seemingly have no relationship to each other.

Q. And a correlation of 1 would be tightly clustered around a line, correct?

A. That's correct.

Q. Okay. Do correlation coefficients have limitations in terms of what they can tell you?

A. Yes. Correlation coefficients are limited in that they can only tell you, again, how close the values of those two

variables are to a straight line.

So if your variables are related to each other in anything but a linear fashion -- that's what we mean by a straight line -- a correlation coefficient cannot tell you anything about them.

They are also highly susceptible to distortion by outliers. And this is best I think illustrated if I can draw a picture. Would that be all right?

Q. Absolutely. Okay.

A. Okay. Can everybody see that? So as I was saying, in the top graph we can see that our X and our Y axis, they're clearly related to each other. They're a curved linear relationship. Naturally we see relationships like this, for example, in medication use where we see an improvement, but then we see a deterioration because you're giving more medication to sick people. It's an example of that.

MR. LOVETT: Your Honor, may I approach and stand --

THE COURT: Go ahead. Certainly get where you need to.

THE WITNESS: So you can see it. You can see that the correlation is zero when, in fact, we have a very distinct relationship between the variables. So the correlation coefficient just can't tell you about that.

The second graph shows what is clearly a linear relationship, but we have one small point down on the bottom

right here, and that outlier throws off the correlation. And so it tells us we have no correlation when, in fact, most of our data actually say we do. We have a nice straight line there.

The bottom is another example where most of our data is down in the bottom corner. There's not necessarily a good relationship, but we have one point that is all the way up in the top right-hand corner. And because of that, it detects that as being a straight line. And so our correlation is actually inflated. It's .99, close to 1, when, in fact, we don't have a relationship.

So correlation coefficients can be very misleading in terms of their ability to tell us about our data.

BY MR. HARVEY:

Q. Is that true for ecological data as well as medical data?

A. It's true for any data.

Q. Okay. Is correlation the same thing as causation?

A. No, it is not.

Q. Give me an example to help me understand.

A. So, for example, we might find that gray hair is highly correlated with dying. We might find that the correlation is, you know, 80, 90 percent, but that doesn't mean that having gray hair causes you to die. And it illustrates the point that correlations are symmetric. There's no indication of directionality. You can't use them to establish causation;

and, in fact, there's a number of textbooks and articles that have -- that warn against using correlation coefficients to establish causation for that very reason.

Q. In fact, that's a principle explained in most epidemiology and statistics textbooks, correct?

A. That's correct.

Q. Correlation does not equal causation.

A. That's correct.

Q. Is Rothman's book on *Modern Epidemiology* a reliable treatise on the subject?

A. It is an authoritative textbook on the subject of epidemiology and the application of statistics in epidemiology.

Q. I'm going to show you a passage from page 185 from that treatise.

A. Yes.

Q. Mr. Tyree is going to put it on the screen.

MR. LOVETT: Your Honor --

THE COURT: Hold on.

MR. LOVETT: Is this in your --

MR. HARVEY: This is Defendant's Exhibit 21.

MR. LOVETT: Well --

THE COURT: Is this something she relies on in her report?

MR. HARVEY: Yes. Yes. It's listed in her report.

MR. LOVETT: It's *Modern Epidemiology*?

MR. HARVEY: Yes, by Rothman.

THE COURT: Are you going to have her read this?

MR. HARVEY: I'm going to try to avoid as much of it as we've seen, Your Honor.

BY MR. HARVEY:

Q. Miss Kuehn, does this text from Rothman help explain the principles of causation and association?

A. Yes, it does.

Q. Can you read only so much of it as might inform the Court about that commonly understood principle?

A. Sure, you bet. So Rothman's book talks first about the fact that causation and association are qualitatively different concepts, that they are not the same thing.

He goes on to say, similar to what I was just noting, that causal relations are directed. Associations are undirected. They are symmetric. There's no sense of directionality.

And as I mentioned, he also states that sample associations are directly observable, but causation is not. And when we talk about samples, we're talking about data gathered from the entirety of the population. We have to sample that data. That's the dataset that we use. So we observe associations in samples because we cannot observe causation as it occurs.

So he goes on to say that -- and I'll quote. Our intuition tells us that associations are the result of causal forces. Most obviously, if X, which would be our exposure, causes Y, which is our outcome, this will generally result in an association between X and Y.

He goes on to state, though, that the catch, of course, is that even if we observe X and Y without error -- so if all of our measurements are absolutely perfect -- many other forces, such as confounding and selection, may also affect the distribution of Y -- in other words, the outcome that we are interested in -- and thus induced an association between X and Y that's actually not due to X causing Y.

So he's talking about confounding here, which has been something we've talked about quite a bit.

Q. Let me ask you, what is confounding?

A. What is confounding? Confounding is a distortion of the -- is the distortion of an observed association. So it's the distortion of an effect of an exposure on an outcome that we might observe in our observational data.

It can also be called a mixing of effects, but essentially confounding is when you observe an association between an exposure and an outcome but that observation is actually distorted by another factor.

Q. I think you've prepared an exhibit, Defendant's Exhibit 1. Mr. Tyree, can you put that on the screen, please?

MR. LOVETT: I'm sorry to interrupt, but could you tell us the page number? We can't find that in --

MR. HARVEY: It's under tab 1. It's only one page.

THE COURT: Tab 1, volume 1 of Defendant's?

MR. HARVEY: Yes, Your Honor.

MR. LOVETT: I need the page that she just read from, the page, the Rothman page.

MR. HARVEY: Oh, the Rothman?

MR. LOVETT: It was a very long book that you gave us. I don't know the page on which to find that.

MR. HARVEY: Page 185.

THE COURT: All right. Let's say this into the record. Mr. Harvey, will you provide us with the page number from the quote from the book that she read?

MR. HARVEY: Yes, Your Honor. It is on page 185 of *Rothman on Modern Epidemiology*.

THE COURT: And that's one of the defense exhibits?

MR. HARVEY: It is, Your Honor. It's Defendant's Exhibit --

MR. LOVETT: We found it. Thank you.

MR. HARVEY: -- 21.

THE COURT: All right.

BY MR. HARVEY:

Q. Miss Kuehn, do you recognize Defendant's Exhibit 1 shown on the screen?

A. Yes, I do.
Q. Can you use that exhibit to explain the concept of confounding to the Court?
A. Yes, I can. So what we see here is E, which is our exposure of interest, is -- has an effect on Y. Y is our outcome. So, for example, in the issue at hand here, E would be conductivity. Y would be impairment. And so we're interested in the effect of the exposure on the outcome.

What the diagram shows, however, is that C, which is your confounder in this case -- this could be temperature, habitat, any of the other confounders that have been identified or potential confounders -- is a risk factor for the outcome and also is associated with the exposure. And so this diagram simplifies the concept of confounding. Instead of just being able to observe the effect of the exposure on the outcome, we have to take into account the confounding effects of the confounder.

Q. Do you recall the discussion between Dr. King and me about asbestos and lung cancer and smoking being a potential confounder?
A. Yes.
Q. Were you present for that?
A. Yes, I was.
Q. Is that a good example of the concept of confounding?
A. That's an excellent example of confounding.

Q. Because asbestos may be associated with smoking, correct?
A. Absolutely. It could be related to the fact that the workers can have an increased frequency of smoking or what have you, and smoking is clearly a risk factor for lung cancer. So, sure.
Q. Do most textbooks and treatises in statistics and epidemiology address the issue of confounding?
A. Confounding is an important -- I can't emphasize enough, a very important topic in epidemiology and statistics, particularly as it concerns the analysis of observational data, because we have no control over the occurrence of that data. It's not an experiment. It's uncontrolled. That's why we call it observational.

We have to take into account confounding. And the textbooks on this topic will include chapters on confounding, and nearly every chapter in every textbook I've ever looked at talks about confounding. It's a very big deal, particularly with observational data.

Q. Is it something that can affect ecological data?
A. It can affect any data where we're looking at an exposure on an outcome and the data that we are examining or analyzing is observational, which is exactly what this dataset is. So, absolutely.
Q. I'd like to return to *Rothman on Modern Epidemiology*, particularly page 129 from Defendant's Exhibit 21. And

Mr. Tyree has put a section of that book on the screen.

Does this help explain the concept of confounding?

A. Yes. So as I stated, a simple way to describe confounding is stated there. It says, "On the simplest level, confounding may be considered a confusion of effects." They go on to state that the apparent effect of the exposure of interest is distorted because the effect of extraneous factors, potential confounders, is mistaken for, or mixed with, the actual exposure effect, which may actually be null, which means it may actually have no effect.

The distortion introduced by a confounding factor can be large, and it can lead to overestimation or underestimation of an effect. And, again, this depends on the direction of the confounding and the direction of the effect of the exposure on the outcome. So it can have a very large effect on the results of any analysis.

Q. And confounding can be hard to identify, correct?

A. It can. Confounding can be subtle. Understanding the potential confounding effects of extraneous factors is a major source of anxiety for most epidemiology students. It's not a simple concept to necessarily understand or apply.

You can have very subtle effects of confounding that end up having a large impact on the estimate of the effect of the exposure of interest, on the outcome of interest, and so it's very important that it be addressed thoroughly and correctly

in the analysis.

Q. Can confounding lead to spurious conclusions if not properly addressed?

A. Absolutely. So, again, if we have confounding, that means that the exposure and outcome relationship that we're observing in our analysis is not correct. It's distorted by something we have not controlled for or adjusted for.

So if we fail to take it into account, then what we observe is actually not the true association between that exposure and the outcome. So it's incredibly important. So without good identification of confounding, appropriate adjustment for a confounding in the analyses, the results that you get can be completely meaningless.

Q. Well, how do we identify confounders? Can you use statistics to identify confounding?

A. Absolutely. So you can use statistics. You can use a priori information or knowledge that you have about potential confounders. There are a number of ways that we go about identifying confounding and then determining whether potential confounders actually have an effect on the relationship of interest.

Q. Can you use regression to identify confounders?

A. We can use regression to determine if a potential confounder has an effect on the relationship of interest. In other words, we can use regression to determine does that

extraneous factor distort the effect that we are observing.

Q. Now, I think the SAB -- and Dr. King and I talked about this. The SAB panel recommended that EPA use regression.

A. Yes.

Q. Can you tell the Court what regression is?

A. Regression is a statistical technique that we can use to model, is what we call it, to model our data such that we can examine the actual effect of the exposure on the outcome.

This is very different than what we were talking about before which can't tell us how one variable affects another. Regression allows us to examine that. And we use regression to estimate for what are called parameters. So these are the beta coefficients. And I can draw another picture if that's helpful, but they provide us with estimates of how much the outcome changes with a change of exposure. And then we use statistical tests to tell us whether that change is statistically significant. And so we can use the regression to do that.

The other thing we can do with regression is adjust for confounders. And so we can include those in our model in such a way that we remove that distorting effect on the observed associations.

Q. Are there different kinds of regression?

A. Yes, there are a number of different kinds of regression.

Q. Do they depend on the type of data you're analyzing?

A. Yes, they do. This might be a good opportunity for a picture, if that's all right. Okay.

MR. LOVETT: Your Honor, again, I object to this. I don't see anything about a regression analysis or explanations about that in her report.

THE COURT: Well, I'll let you respond to that when she finishes her drawing.

MR. LOVETT: Okay.

THE COURT: All right. Mr. Harvey, can you respond to the objection?

MR. HARVEY: Yes, Your Honor. The report from Miss Kuehn, which you've already read, talks about the failure of both EPA and Dr. King to use proper statistical techniques.

One of the techniques that should be used -- and this was stated by the SAB -- was regression. And Miss Kuehn would like to talk about the failure of both Dr. King and EPA to use regression, why is it important, and it's a simple background on regression. And I think she does specifically reference regression in her report, if you'd give me one moment, Your Honor.

If I may, Your Honor, this is -- I'd like to read from Miss Kuehn's report.

THE COURT: Go ahead.

MR. HARVEY: "Correlations such as those described" --

THE COURT: Well, tell us where you are first.

MR. HARVEY: It's on page 9. We can put it on the screen as well, Your Honor.

THE COURT: I've got it.

MR. HARVEY: Okay. It says, in the highlighted part, Your Honor, "Correlations such as those described in Dr. King's report are not considered to be measures of effect, and thus should not be used to establish causation. Multivariate modeling, including regression that controls for confounders, would be a more appropriate means by which to evaluate the relationship between exposure and outcome in this situation."

MR. LOVETT: Your Honor, that is the only mention of the word "regression" in the entire report, and it's very theoretical on a very general level. So I mean --

THE COURT: Well, I'm going to overrule your objection.

MR. LOVETT: Okay.

BY MR. HARVEY:

Q. Are you finished with your --

A. I am finished drawing. If someone wants to hold it up, I can --

Q. Okay.

A. I can explain. All right. So I believe the question was related to different types of regression. So there are

different kinds of regression to -- meant to handle different kinds of data. And so the most familiar regression is what we call linear regression. All of these can be multi, so multi-linear or multi-logistic. Basically "multi" just means they have more than one variable predicting the outcome.

THE COURT: I'm sorry to interrupt. Shane, why don't you stand over in the jury box and put that on the rail. It would be easier for me to see.

THE WITNESS: Okay.

THE COURT: Back up a row. If you'd go to that next row back. Is there anything there?

MR. HARVEY: There is, but I'll navigate.

THE COURT: All right. That's much better for me. Can you see it okay there?

MR. LOVETT: Yes. Thank you, Your Honor.

THE WITNESS: So what I've done here is I've given you a little cheat sheet on regression. Okay. So we have the type of regression, the type of data that that regression is designed to handle, an example from this case of the type of data and the estimate.

I want to emphasize that the data type is the type of data that is your outcome. Okay. So when we look at linear regression, we're modeling a continuous outcome measure. You can have all different kinds of predictors, but your outcome measure is what determines which model that you use. Okay.

So in this example, we might use linear regression on WVSCI score. It's a relatively continuous variable. And what that would give us is an estimate in the form of a coefficient. And that coefficient would tell us to what extent the outcome, WVSCI score, changes with a change in our exposure, and we would get a p-value that tells us if that change is significant. And then we could also include variables in the model for potential confounders, and we can evaluate whether or not they have an effect on that estimate and so forth. So that's the first one.

The second one is logistic regression. And logistic regression is specifically designed to model a binary outcome. This is a yes or no, cancer or no cancer. In this case, we might use it to model WVSCI above the 68 threshold or WVSCI below. And, again, we would put a number of predictors in the model, conductivity being the exposure of interest. And what that model would estimate for us is called an odds ratio.

That odds ratio would tell us whether or not there is an increased or a decreased risk for WVSCI scores of above 68, depending on how you code it, with an increase in conductivity. And you can flip that around.

So let's say we wanted to know what the increased risk was for an impaired score, and we could model our data such that we could find the relative increased risk in an impaired score based on a change in level of conductivity, and we could

control for potential confounders, etcetera. So that's how you would use logistic regression. And, again, we would get p-values to tell us if those odds ratios were significantly significant.

Finally, we have Poisson or a negative binomial regression. I think we talked a little bit about this earlier. This is appropriate for using with count data when your data is of the type. In this case, number of bugs or number of genera is a good example. And what that estimates for us is called a rate ratio, and it tells us the risk of an increased rate or, in this case, an increased count or a decreased count with a change in our exposure variable. And, again, we can control for potential confounders in that model. So it would give us a p-value to let us know whether that change was significant.

MR. LOVETT: Your Honor, I didn't interrupt, but none of this is in her report. The word "Poisson" does not appear in her report. I understand the word "regression" appears. This is an exhibit really that was not given to us. It's being created here because it wasn't in the report.

THE COURT: Well, as I understand it, in her report she made clear that she objected to or criticized the statistical methodology used for the benchmark and by the experts for the plaintiff, as well as a number of these studies.

MR. LOVETT: Yes.

THE COURT: I think she's entitled to testify about her criticism of the use of these statistics and these models. And now, as I understand it, she's explaining the model or the statistical method that she thinks should have been employed which she made reference to in her report.

MR. LOVETT: I understand, Your Honor. Dr. King has never had the opportunity to review this document. He can't see it. She didn't say anything in her report about it, and --

THE COURT: What document are you talking about? The drawing?

MR. LOVETT: The document just created with the --

THE COURT: I view this as nothing more than an expert giving background explanation about the principles that she is going to employ in her testimony. I don't see it as a problem.

BY MR. HARVEY:

Q. Miss Kuehn, is data quality important in the field of statistics and epidemiology?

A. Yes, data quality is very important. We want to make sure that the data we are using to measure exposure, measure confounders, measure our outcome are as accurate and precise as possible.

When we have a lack of data quality, this can introduce

things like bias in our results and actually can severely limit our ability to infer or make conclusions about the results of our analysis.

Q. We'll talk about this more later, but did you hear Dr. King talk about snapshot data being almost useless I think was his quote?

A. Yes, I did hear him talk about that.

Q. Is there a danger in using snapshot data in a study such as this?

A. In a study such as this where you have factors that change repeatedly over time, using snapshot data can be particularly problematic because you don't have an opportunity to take into account that variation.

We have two things that, if I understand correctly, change quite a bit. One is temperature, which changes on an hourly basis in addition to on a monthly and seasonal basis. So based on what I read in the benchmark, nearly all of these sites had only one set of measurements. So we only have one temperature for any particular site. And the problem you run into is whether or not that temperature is actually a good reflection of the overall temperature profile of that site.

So it is problematic, and it limits our ability to understand the effect of temperature on the outcome, the effect of temperature as a confounder.

Similarly --

MR. LOVETT: Your Honor, I apologize. In her deposition when asked if she had an opinion of data quality, she said, quote -- this is on page 94 -- I have not evaluated this data for its quality. So I believe the opinion in my report was to the extent that there are problems with the data, which I have not analyzed, that it could lead to problems with the results.

For her to now testify about data quality, you know, there's nothing in her report about it, and she disavows it in her deposition.

MR. HARVEY: Your Honor, we'll look at that. I don't know. We'll move on for now.

THE COURT: All right. Let's move on. I'll reserve the objection.

MR. HARVEY: Okay.

BY MR. HARVEY:

Q. Did EPA claim to use epidemiology in creating the benchmark?

A. Yes, they did.

Q. I'd like to turn your attention to Joint Exhibit 58, page 386.

Mr. Tyree, if you can put that on the screen, Miss Kuehn, you won't have to look for it.

May I approach, Your Honor?

THE COURT: Yes, you may.

BY MR. HARVEY:

Q. Here, Miss Kuehn, EPA says -- and I quote -- "The evidence for and against salts as a cause of biological impairment is weighed using causal criteria adapted from epidemiology."

Do you see that?

A. Yes, I do.

Q. Mr. Tyree, can you turn to page 429 in the same exhibit, Joint Exhibit 58.

And, Miss Kuehn, does this page similarly say, "The inferential approach is to weigh the body of evidence, as is done in epidemiology"?

A. Yes, that's what it says.

Q. And I think this page is under appendix A, which they refer to as a causal assessment; is that correct?

A. Yes.

Q. And further down under section A1, EPA says, "To assure the association of conductivity with the extirpation of aquatic taxa reflects a causal relationship, we use epidemiological arguments."

Do you see that?

A. Yes, I do.

Q. And there are other examples throughout the benchmark where EPA purports to use epidemiology, correct?

A. Correct.

Q. And in the papers of Suter and Cormier.
A. Correct.
Q. Do you think it was appropriate for EPA to apply epidemiology to this issue?
A. Absolutely. I mean this is the type of dataset that we use in epidemiologic research. It's an observational dataset with measures of exposure and measures of outcome, and the statistical techniques and methods used in epidemiology are entirely appropriate.
Q. I know you have some issues with the data quality, but beyond that, the approach is something you're familiar with and you think is acceptable.
A. Absolutely. We use limited data all the time, and the key is to take into account those limitations when making inferences based on our analyses.
Q. Now, let me ask you this. Did EPA properly apply epidemiologic methods in their study of conductivity?
A. No, they did not.
Q. Did you see the discussion between Dr. King and myself on some of the concerns raised by the Science -- Scientific Advisory Board?
A. Yes, I did.
Q. Mr. Tyree, can you put those on the screen? Those are found in defense -- my writing might be -- maybe it's Plaintiffs' Exhibit 25. I'm sorry. Plaintiffs' Exhibit 25,

page 402.

And Dr. King earlier read this statement, Miss Kuehn. It's on the screen behind you. I don't know if you have it in front of you now.

A. No. I can see it on the screen.

Q. You're familiar with it, though?

A. Yes, I am.

Q. Without reading it again into the record, what essentially is the SAB telling the EPA in this paragraph?

A. The SAB is recommending that EPA employ some additional multivariate statistical methods to evaluate confounders in particular. They also are asking for clarification on why other multivariate methods were not used to evaluate the exposure and outcome relationship of interest.

Q. Do you have similar concerns about the benchmark?

A. Yes, I do.

Q. I'd like to show you next Joint Exhibit 58, page 475. This is something else that Dr. King and I discussed.

Here, EPA responds to the SAB's concerns, correct?

A. Correct.

Q. And they explain why they did not use multivariate statistics, correct?

A. Correct.

Q. Tell me what you think about their explanation.

A. It's nonsensical, to be blunt. Firstly, they confuse the

recommendation to use multivariate statistics as a request that they use that instead of their weight of evidence technique; and they seemingly fail to recognize that what the SAB was asking them to do, and what my criticism is, is that they needed to apply multivariate statistics to examine the relationship between conductivity and impairment and evaluate confounding.

The results from those analyses would feed into a weight of evidence for causation. They're two separate things, and EPA seems to conflate those.

The other thing that really doesn't make sense is they actually state that it would not be appropriate to use multivariate statistics on these data, which is, again, just nonsense. This is exactly the kind of data that these statistical tools are designed to be used for. So it simply doesn't make any sense to me.

Q. If you were to pick up any textbook on statistics or epidemiology, there would be discussions about using these tools on this type of data, wouldn't there?

A. Absolutely.

Q. Even though EPA expressed the reservations that they had in this paragraph, did they ultimately perform a multiple regression analysis?

A. They appeared to have performed some multi-linear regression, yes.

Q. Okay. I don't know that Dr. King pointed us to that in his testimony today, but I'd like to clarify that for the Court. If we could turn to Joint Exhibit 58, page 482.

What is this, Miss Kuehn?

A. This appears to be output from two linear regression models. The first model is described in those top few rows where it says Univariate Model. "Univariate" means they had one variable in the model. And then there's a multivariate model below that.

Q. And it looks like they're trying to analyze certain confounders in the benchmark?

A. Yes. So the univariate model includes conductivity, and the multivariate model includes conductivity, RBP slope, temperature, and fecal coliform slope.

Q. Is this a proper regression analysis?

A. Well, the outcome that they were examining was predicting the bug genera as far as we can -- I can tell from their description, whether or not the bugs are present or counts of genera.

So as I explained before, when we have count data, we want to use the appropriate model for that data. And here, they used linear regression --

MR. LOVETT: Objection, Your Honor. She is not -- she has testified in her deposition that she is not an aquatic ecologist. She has no knowledge of what appropriate data are.

She may be able to determine if data have been analyzed in a particular way, but to determine which data are analyzed is beyond her -- not only the scope of her expertise but the scope of what she said in her deposition.

THE COURT: Overruled. I'm going to permit her to testify. She's testifying as an epidemiologist to the appropriate use of these regression analyses. I don't think at this point that she's required also to demonstrate that she has this ecology background.

She's testified that from her knowledge of this, this is an example of the type of data that requires a particular model to be used to determine if they used properly a regression analysis.

THE WITNESS: So, again, they used linear regression on what appear to be count data. If it was present or absent, we would want to use logistic regression. So they are applying the wrong model to the data.

The other problem here is we can't tell anything about their output. They have neglected to provide us with any of the statistical tests' information that we need to know. So you can see here where it says conductivity slope, minus 0.93, and it provides us with a standard error, what I need to then see is, was that statistically significant? Did conductivity statistically predict the outcome?

Now, this is the wrong model, but if it was the correct

model, we still don't have the information we need. So while they've provided us with some output here, it's uninterpretable given what they've got in that table.

BY MR. HARVEY:

Q. Are you familiar with a textbook by Koepsell and Weiss on epidemiologic methods?

A. Yes. Actually, Drs. Koepsell and Weiss were graduate school professors of mine, and my cohort actually helped them edit that book.

Q. I'd like to show you Defendant's Exhibit 22, page 263, from that treatise.

MR. LOVETT: I'm sorry, Your Honor, but is this cited? I don't see it, Koepsell and Weiss.

MR. HARVEY: Koepsell and Weiss, yes, it is.

MR. LOVETT: Okay. Oh, there it is. Sorry.

THE COURT: What volume are you in?

MR. HARVEY: Defendant's Exhibit 22. I don't know that -- volume 2, Your Honor. Volume 2. My mistake, Your Honor.

BY MR. HARVEY:

Q. What does this table or output on page 263 show, Miss Kuehn?

A. So this is what we would typically desire to see in a regression output. This happens to be from a logistic regression, so, again, a binary outcome.

What they show us is the first model, which has our exposure, which here happens to be oral contraceptive use -- this is a study looking at cardiovascular disease in women who have taken oral contraceptives.

So they provided us with the point estimate in the first model. Then the second model, they are examining the effect of -- looks like something having to do with physical activity I think is what that stands for.

So you can see the left side of the table is similar to what EPA provided us. There's the point estimate and standard error, but now we have the rest of it. We have the p-values. And that tells us whether or not the exposure of interest is a significant predictor of our outcome.

We also have the odds ratio, which is what the logistic regression calculates for us, and that's actually calculated from the point estimate, and then we have a confidence interval.

So we can see in this model whether or not we have statistical significance in the parameters being estimated by the model. And that's what we need to see in order to interpret regression output.

Q. Other than this flawed regression analysis that EPA performed and the paragraph saying, "We disagree with you, SAB," did EPA do anything else to address the SAB's comments as far as you're concerned?

A. Not as far as I can tell, no.
Q. So if EPA didn't run proper statistical models, how did they address confounders?
A. Based on what I read in the benchmark, EPA applied their own criteria and what appears to be a weight of evidence technique that we would normally use for causation. I think it's loosely based on Bradford Hill, which is a set of criteria -- and I say that loosely -- that we use to evaluate causation.

Bradford Hill is -- it's very rare that -- we don't -- we don't look at it as a checklist. It's sort of a guideline for establishing causation. But, anyway, EPA used these weight of evidence criteria, and the criteria they listed in appendix B, and came up with an assessment of confounding that is nothing like any established techniques for identifying, controlling, or adjusting for confounding. I've never seen anything like it.

Q. Is that the plus plus plus, plus plus, minus minus information --
A. Yeah.
Q. -- that Dr. King read into the record today?
A. Yes, it is.
Q. Are the amounts of pluses and minuses entirely subjective in your view?
A. As far as I can tell, yes.

Q. Does it relate in any way to what Sir Bradford Hill did as an epidemiologist?

A. If we're talking about causation, one could argue that the weight of evidence technique has some linkage, if you will, in Bradford Hill, but that's establishing causation. And what again happens here is EPA appears to conflate the assessment of confounding with establishing causation. And they really are two separate things.

When we look at confounding, we're looking at the effect of these potential confounders on the observed relationships that we are calculating using our models. We look at confounders. Do they affect the relationships of interest? Do we have a prior knowledge that would tell us that this factor could potentially distort this relationship? That's an assessment of confounding.

The weight of evidence technique, the causal philosophy, if you will, is a completely separate issue; and the results of our analyses feed into that and can be used in that weight of evidence, but weight of evidence itself is not a means by which we assess confounding.

Q. Okay. Let's look at an example.

A. Okay.

Q. This is an example that Dr. King and Mr. Becher discussed. It's found in Joint Exhibit 58, in the benchmark, page 493. Has everyone got to their proper place in the

notebook?

Miss Kuehn, this is a table that EPA prepared that looks at temperature, correct?

A. Correct.

Q. And analyzes whether or not it's a confounder, correct?

A. Correct.

Q. And Dr. King and Mr. Becher talked about this table today, correct?

A. Yes, I believe so.

Q. Okay. Let's walk through some of these steps. Let's look at the first one. What is EPA doing in step one?

A. So in step one, they are evaluating the correlation between temperature and conductivity, so the relationship between temperature and the exposure. And they used a correlation coefficient which tells them that the two variables are correlated. R equals .39. So they're moderately correlated. And they're trying to meet one of their criteria for a confounder, which is a relationship with the exposure.

Q. Okay. Dr. King and I talked about this some, but I'd like to look at the background for that .39 in this table, and that's found in figure 13e of the benchmark, which is Joint Exhibit 58, page 414.

Do you recall this matrix, Miss Kuehn?

A. Yes, I do.

Q. What does this tell us about the correlation between temperature and conductivity?
A. That it is 0.4.
Q. And do you see the graph, the second graph down the left-hand side?
Mr. Tyree, can you blow that up?
What does that graph tell us about the relationship between temperature and conductivity?
A. Basically it tells us that as temperature goes up, conductivity goes up. And you can see with the red line, it kind of slopes gently upward. That's about all that tells us.
Q. And I'm not sure what Dr. King ultimately concluded on this point, but would you describe this relationship as a weak relationship?
A. I would say they're moderately correlated, but I would also use other evidence for the relationship between conductivity and temperature besides just this correlation to establish the relationship between the two.
Q. And EPA found this correlation to be moderate, didn't they?
A. Yes, they did.
Q. Would you rule out temperature as a confounder based on this correlation of .4?
A. No, not at all.
Q. Why not?

A. Well, we have other information that tells us that conductivity and temperature are related. There's clearly over the seasons as temperature goes up, conductivity goes up. When temperature goes down, conductivity goes down. So they're moving together in a seasonal way.

We can see that graphically. I would look at it graphically. And even Dr. King himself has stated that temperature and conductivity tend to move together.

So there's ample evidence that temperature and conductivity are somehow related. So they certainly meet that particular criteria for -- or criterion, rather, for a potential confounder.

Q. Dr. King -- if you could go back to table B-20, Mr. Tyree -- he noted that EPA did find a moderate correlation for conductivity and temperature in the entire dataset, but then he pointed out there was a second dataset, EPA dataset, with 46 observations where they came up with a lower correlation and pointed out that EPA therefore reduced the score, overall score, to zero.

Do you think that was appropriate?

A. I'm not sure why you would do that. So, again, the correlation is just one piece of information. And why you would reduce your dataset to 46 when you have 2,200 observations that tell you that conductivity and temperature move together, they're related to each other, why you then

rely on a much smaller set of data is baffling to me.

Again, you have ample information that says that temperature and conductivity are related. It's very simple. And so it meets that criterion for being a confounder.

There's no explanation here for why they would reduce their data in that way and then rely on that correlation coefficient.

Q. All right. EPA next in step two looks at the correlation between mayflies and temperature; is that correct?

A. That's correct.

Q. And they gave this score a -- they gave the score one minus. Do you see that?

A. I do see that, yes.

Q. Based on the fact that there was a low correlation between temperature and Ephemeroptera. Do you see that?

A. I do.

Q. Do you agree with that analysis?

A. No.

Q. Why not?

A. Well, there's a couple of reasons. One is, again, if we're looking at count, count data is not going to be linearly related with conductivity -- or, I'm sorry -- with temperature. And so using a correlation coefficient to compare those two doesn't work. It's not a linear relationship.

The second reason is we -- EPA is clearly ignoring a priori knowledge that temperature is a potential risk factor for the viability of organisms in these streams. There's --

MR. LOVETT: Objection, Your Honor. She's testifying way beyond her area of expertise and beyond her report and everything else.

THE COURT: You haven't laid a foundation for her to testify about this.

BY MR. HARVEY:

Q. Have you been present for Dr. King's testimony?

A. Yes, I have.

Q. Were you present at his deposition?

A. Yes, I was.

Q. Did he describe temperature as a risk factor for mayflies?

A. I believe he did, yes.

Q. Something that could affect the WVSCI score?

A. That's correct.

Q. And EPA does the same in the benchmark, correct?

A. That's correct. They identified it as a potential risk factor.

Q. That's the reason they're looking at temperature, right?

A. That's exactly right. And they apparently ignore their own information and rely on these correlation coefficients. Again, when we look at potential confounders, relying on a

statistic like this is not appropriate. You need to take in all of the information you have about that potential confounder, and they simply failed to do that.

Q. When Dr. King and I discussed, again, smoking and lung cancer --

A. Uh-huh.

Q. -- he conceded, did he not, that he would not rule out smoking as a potential confounder for lung cancer in a study, because it's a risk factor; right?

A. That's correct, and we have ample a priori information to tell us that that's the case. It is absolutely valid to address or assess the effect of a potential confounder simply based on your a priori knowledge about that confounder as a risk factor for your outcome and as it being related to exposure.

Q. Well, what about the fact that the relationship between smoking and lung cancer only explains 8 percent of the variance? It has a very low correlation.

A. That 8 percent is irrelevant in terms of smoking's confounding effect on the relationship. You can have a very weak correlation or variance accounting between your potential confounder and your outcome and your potential confounder and your risk factor and it can have a very strong confounding effect.

It's a mathematical relationship. It is a -- it is not

something that you can simply ignore because you have a correlation coefficient that's very small.

You have to take into account all of the information. And if you're still not sure, you can do iterative modeling with the regression analyses that I described and see if it has an effect on your outcome, and if -- or, I'm sorry -- an effect on your risk estimate or whatever parameter you're estimating. And if at that point it does not appear to be altering the relationship, then you can probably not adjust for it. But until you've done all of that, you have to take it into account and adjust for it in your models.

Q. Let's talk about EPA's third step, which involved the use of a contingency table that Dr. King and I discussed today, table B-19, which is in Joint Exhibit 58, page 492.

I know this is one of your favorites, Miss Kuehn. Tell me what this table shows.

A. This table gives us the frequency of the presence of these bugs for streams that have conductivity levels less than 200 microsiemens per centimeter and conductivity greater than 1500 and for temperature below 17 and above 22 degrees. And that's about it. It provides us with frequencies.

Q. Well, I mean you heard Dr. King. As long as conductivity is low, we find mayflies 99 percent of the time at low temperature and a hundred percent of the time at high temperature. Why is that not compelling?

A. Frequency tables are useful for illustrating our data, summarizing our data, but they have to be interpreted very carefully because the frequencies that you observe there can be misleading.

First of all, we're missing an enormous amount of data here. There are categories of conductivity and temperature that are not included in this table, and we know nothing about that data. It is impossible to interpret what this means without the entirety of the data.

They simply picked the lowest and the highest, and that's all we know. So that's a serious problem. We simply would not do that in epidemiology or biostatistics.

The other problem is, you can't infer any type of effect or causation from this because, again, we haven't taken into account habitat, we haven't taken into account any of the other potential confounders. And since those have not been evaluated appropriately, we don't know if they could somehow change the way these frequencies are distributed across these cells. So --

Q. Not to cut you off, but did you hear Dr. King tell me that he has no idea whether the habitat is the same for the 1500 conductivity bin as the 200 conductivity bin?

A. That's correct. You can't tell that from this table, and that's incredibly important.

Q. You can't compare apples to apples without knowing what

the habitat is, right?

A. You cannot. There's a lot of information missing from this table that renders its value very low.

Q. Is this snapshot data?

A. Again, all of this data is snapshot data. As I described earlier with temperature, we don't know if that is representative of that stream in general.

Q. Well, you mentioned something to me before also about switching the outcome of interest. What did you mean by that?

A. Yeah. So my understanding of the benchmark is that EPA set out to evaluate the effect of conductivity on impairment. Okay. What we see throughout appendix B where they do this confounding analysis is an evaluation of bugs as the outcome, whether it's count or presence or absence.

While I understand that the presence or absence of those bugs or the number of -- types of bugs is important for -- as being part of the overall impairment of the stream, when we're evaluating confounding, we must stick to the exposure of interest and the outcome of interest and the effect of confounding on that relationship.

If we start evaluating confounding for a different outcome, we've completely changed the question. So looking at here the presence or absence of these bugs tells us nothing about the effects of temperature and conductivity on impairment. This is not representative of that particular

relationship, which is supposed to be the relationship of interest.

Q. This just tells us whether mayflies are present or absent, right?

A. Correct.

MR. HARVEY: And may I approach, Your Honor?

THE COURT: Yes.

BY MR. HARVEY:

Q. In this box here were high temperature and low conductivity. We've got a hundred percent.

A. Uh-huh.

Q. But that only tells us that we may -- that we have at least one mayfly present in this group, right?

A. That's my understanding. It's based on presence or absence. So, yes.

Q. It doesn't tell us the rate of passage for WVSCI scores, does it, at these temperatures?

A. No, it does not.

THE COURT: Hold on just a moment.

All right. We're going to take a recess for the day. We'll recess until 9:00 a.m. tomorrow.

Miss Kuehn or Dr. Kuehn -- is it Miss Kuehn?

THE WITNESS: Miss Kuehn. Thank you.

THE COURT: You may step down. Please don't discuss your testimony with anyone. Other than that, is there

anything else we need to address?

MR. LOVETT: No, Your Honor.

MR. HARVEY: No, Your Honor.

THE COURT: All right. We'll stand in recess until 9:00 a.m. tomorrow.

(Proceedings adjourned at 4:30 p.m.)

I N D E X

I, Teresa M. Ruffner, certify that the foregoing is a correct transcript from the record of proceedings in the above-entitled matter.

/s/Teresa M. Ruffner September 15, 2014